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BRIEFLY TOLD.

DEATH OF MR. GEORGE B. HAND.—Telegrams from Atlantic City, J., dated December 24th, conveyed the news of the death there on t date of Mr. George B. Hand, who for 37 years (from 1869 to 1906) s Secretary and Treasurer of the Scranton (Pa.) Gas and Water mpany. Deceased went to Scranton, from Washington, N. J., in ptember, 1869, to take service with it in a subordinate position. So ll did his work serve that in May, 1873, he was elected the Comy's Secretary, which promotion was in turn (1883) followed by his ming to the Treasurership. An illness beset him in 1899 that was fficiently serious to put him on the furlough list between February, 9 and May, 1900. His enemy was not vanquished, however, for cessive returns of his disorder were experienced until the Spring of 1905. In April, 1906, his condition became such that he resigned from all active work and retired to Atlantic City, battling with disease almost constantly to the end. He was a man of retiring habit, consequently was not well known to his fellows in the gas industry. Nevertheless his effect, thereon, particularly in Central Pennsylvania, was such that his advice, particularly in connection with the legal side of things relating to gas works' administration, was frequently sought. Personally, despite the physical infirmities to which he was subject for a long and weary term, he was especially noted for his kindness to the Company's employees and for his tactfulness in dealing with its patrons.

FEAST DAY.—"It surely was feast day in the premises of the Consumers Gas and Fuel Company, of Atlantic City, the afternoon of Dec. 24. It was the Company's regular meeting day, but regularity was laid aside before dinner; and these things happened: Mr. Charles W. Hoy, the General Superintendent, turning to General Manager, F. B. Aldrich, remarked, 'Boss; time is ticking, so take this.' The outstretched hand contained a beautiful watch, the cases of which were composed of many carats of gold. Of course, the spokesman did more than that, but it was enough. Aldrich struggled through a rather emotional response, which was neither noted for rhetoric nor resonance. However, it did just as well as if it had been prepared by Macaulay and spoken by Demosthenes. The echoes of poor Aldrich's wail were scarce washed away ere the voice of another speaker smote space. This time General Superintendent Hoy had thrust upon him a highly jeweled Masonic ring, and it was Hoy's time to talk. Manfully and well he uttered his tune of thankfulness, although, to tell the truth, he looked for a moment or two as though he wished he were again back to the shores of dear old Rockaway Point, even though it were one of those early evenings in summer when the 'main holder' was but three sheets out of the pit. However, all's well that ends well, and the finish to the festivities was of the order that should mark the eve of Christmas.—F. M."

TEACHING "JOHN CHINAMAN" AS TO THE VALUE OF COKE.—The Consolidated Gas Company, of New York, has adopted a plan for putting coke into the laundries of the Chinese of the greater city, which, although not in complete working order yet, has even now been sufficiently tried out to prove that it is going to be productive of excellent results. The skeleton of the plan may be thus articulated: Two column spaces have been reserved in the two prominent Chinese newspapers—*Herald* and *Reform News*—of the city, which spaces are devoted to the values of coke as a fuel for the purpose in hand, the price at which it will be delivered, the time and method of deliveries, etc. A fair share of the descriptive matter has to do with different apparatus for coke burning and the like. In addition, a monthly mailing list has been established, through which will be distributed Chinese literature respecting the merits of gas and coke. Besides the printed matter, calendars, blotters, postal cards, etc., all sufficiently covered with the characters of Confucius, *et al.*, will be mailed occasionally to every Celestial in the neighborhood. This scheme, we think, originated with Mr. McLean, and the burden of its execution will devolve likely upon Mr. De Freitas and his assistants.

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A BENCH OF NORTH AMERICAN VERTICALS.—Now that the subject of vertical retorts is receiving so much close attention from the gas fraternity, it will no doubt be of interest to say to our readers that a bench of verticals, built by the Laclede-Christy Company, of St. Louis, Mo., from American designs, out of American material, and of American construction, is now working satisfactorily in America. We are asked not to divulge the name of the place (which, of course, is known to us), that restriction likely being traceable to the wish of the Laclede-Christy folks to be the first to give out such information on the firm's account. However, be that as it may, the bench under consideration is, so far as our knowledge goes, the first one of the vertical type of settings to be operated in commercial way in North America, it having been practically completed a year ago. As its completion, however, was in a season too late for the needs of the Company, the bench was not fired up until this fall. It has now been in operation for something over 2 months. The retorts are burning off 1,500 pounds of washed pea coal, which contains at least 10 per cent. moisture, which means, of course, at times considerably more, for the coal at this time of the year is shipped unprotected, and practically used directly as it is unloaded. The coke made is very dense, and of a silver-grey appearance, very much resembling oven coke. There is practically no difficulty with the charge dropping from the retorts, it being very seldom the case that any part of the charge hangs up. The bench heats not only very evenly from front to back, but from bottom to top. Up to the present writing the retorts have not developed any signs of failure. No doubt the period or duration of burning could be considerably reduced were it not for the quality of coal being used; but the difference in price between the washed pea coal and the run-of-mine coal would probably not warrant the Company using the latter in preference to the former. These facts were furnished us by a member of the staff of the Laclede-Christy Clay Products Company, thoroughly competent to discuss the question from any point of view, and the Company, as intimated in the opening paragraph of this mention, is ready to furnish any desired information on application.

CURRENT MENTION.——

LAST Friday Mr. F. R. Hutchinson resigned from the sales' division of the Abendroth Brothers, of Port Chester, N. Y., to take up the duties of Commercial Agent for the Atlantic City (N. J.) Gas and Water Company. We congratulate both parties to this agreement, for "Hutch" now has a real opportunity to show his worth and merit, and the Company on the fact that it has retained a man well equipped with both these desirable characteristics.

MR. IRVING BALCOM, who will be pleasantly remembered by many from his connection with the commercial divisions, respectively, of the Western United Gas and Electric Company and the Peoples Gas Light and Coke Company, of Chicago, has purchased a large interest in the "Imperial Press," of Chattanooga, which is one of the largest printing houses in Tennessee. His partner in the enterprise is Mr. W. T. Barr, proprietor of the Chattanooga Printing and Engraving Company, which concern will virtually be merged with the "Imperial Press."

COLONEL IRA C. COPLEY'S new plan in connection with the development of the trading of the United Gas and Electric Company, is to run a high pressure line to and through the settlements between Joliet and Ottawa, Ills. These settlements include Minooka, Morris (the existing plant here has likely been acquired by the Copley syndicate), Seneca and Marseilles.

THE Gas Machinery Company, of Cleveland, O., recently put out from it press "Form 259" of its pamphlet literature. It has to do with "Ammoniacal Liquor, Concentrators and Ammonia," and as is usual with the Company, the doing is done wisely and well. Each of the pamphlet's 18 pages carries something worth reading or examining.

ONE of the noted consumers recently placed on the mains of the South Bend and Mishawaka (Ind.) Gas Company was the huge plant of the Simplex Motor Car Company.

A RECENT issue of the Detroit (Mich.) *Free Press* contains the statement that Messrs. C. H. Geist, of Philadelphia, and R. C. Dawes and I. C. Elston, of Chicago, have completed the sale and purchase of the properties of the Detroit Gas and Coke Company. The latter, during the comparatively short time of its active business life, managed to pile up a floating indebtedness amounting to not less than $50,000.

The Physical Theory of Coal Carbonization.[1]

[Written for the Third Annual Meeting of the American Gas Institute, by MR. W. H. FULWEILER, Philadelphia, Pa.]

Historical Development.—Curiously enough, the first 20 years of the development of the coal gas industry saw, with the exception of the principles of recuperation and the return of waste products, the suggestion and trial of practically everthing that we have to-day. Horizontal, inclined, vertical and revolving retorts, and continuous carbonization and purification and mechanical stoking were all tried out and pretty fairly discussed, so that it has remained for later years to perfect and develop these visionary and paper processes, and make possible the apparent impossibilities of the earlier efforts. All the developments which have taken place in later years have come very slowly and have been thoroughly threshed out in our literature, some of them resulting in violent controversies. These questions or developments have succeeded one another in about the following order:

Replacement of the iron retort with clay retorts.
Removing the back pressure on the retorts by means of an exhauster.
Development of gaseous firing.
Development of recuperation.
Attempted use of tar for gas making.
The use of dry or sealed dip pipes.
Mechanical stoking and mechanical handling of materials.
The inclined retort.
Mixing blue water gas in the retorts, so-called "auto-enrichment."
Coke ovens.
Vertical retorts.

Methods of Supplying Heat for Carbonization.—The carbonization or distillation of coal for the production of gas requires the application of heat (although we shall presently show that the reaction *per se* liberates a small quantity of heat), so that the simplest means of carrying out this process is to put the coal in a pot over a fire. The earliest experimenters did this, and we are still doing the same thing, although we have considerably improved both the pot and the fire. That we are using this method to-day is not for lack of suggestions and inventions of other means of accomplishing this end. The methods other than those which require a heat transfer through the containing vessel may be grouped in three general heads:

a. The use of an internally heated vessel.
b. The use of a body of heated coke.
c. The use of hot gas as a heat carrier.

a. One of the earliest suggestions, under this first heading, was that of S. Cornforth and F. and W. H. Ratcliffe, of England, who, in 1873, proposed to heat a retort with an internal fire by means of a properly regulated jet of steam and air. Details are not given. Two years later J. I. Bennett proposed to build a fire in a retort provided with passages to secure a draft and to circulate the hot products. When a proper temperature was secured the fire was raked out and the retort charged. Nothing came of this patent either.

In 1884 Henry Aitken patented a process similar to Cornforth and Ratcliffe's, where he secured combustion of a portion of the gas in the top of a beehive oven, thus coking the charge and drawing off the remaining illuminating gas through ducts in the floor.

It was not until 1898 that W. Young, W. R. Herring and A. Bell patented a process that was really tried on a practical scale. They proposed a rotating retort heavily lined with fire tile; this had gas discharge pipes in the trunnions and was provided with a charging hole on the side. A charge of hot coke was put in and an air-blast turned on, after the manner of the converter, the retort being rotated; in this way the interior lining and contents were brought to a very high even temperature. The retort was stopped and a charge of coal quickly introduced, the retort being rotated until the coal had been coked by the stored heat. This blowing and charging continued intermittently, dumping out the coke as the retort became too full. Unfortunately, no definite figures were ever given out, although the gas was said to be of good quality. Except for the extent of superheating surface to which the gas was exposed, there is no real reason why this method should not have been successful.

1. Throughout the paper all the units are those in general use in the United States. Temperatures in Fahrenheit degrees; heating value in B.T.U.; tons of 2,000 pounds; candle power, unless specified, reduced to flat flame at 5 feet per hour: gallons, 231 cubic inches. Subscript figures in all cases allude to the corresponding references in the Appendix.

b. Under the second heading, processes making use of a bed of incandescent coke came in with the advent of the water gas process, and a great many schemes have been proposed to utilize the heat stored in a fuel bed and the surrounding brickwork after the "blow." The idea has been to blow up the bed to a high temperature, then charge in a thin layer of coal and withdraw the gas, either through the hot coke bed by means of an exhauster, and thus gasify the tar and secure a non-illuminating gas, or else make a small amount of water or producer gas of very high temperature to carry off the coal gas generated.

The principal difficulties have been: First, the length of time required to coke the coal (though the use of powdered fuel has been advocated to obviate this), and, second, the fact that the green coal would solidify and cake the whole upper portion of the fuel bed together so that it requires frequent breaking up with a bar, a dangerous proceeding with the amount of gas that generally remained in the coal. In their usual form these suggestions provide for a chamber, the lower portion of which is arranged as a producer and provided with air and steam inlets, while the upper portion is arranged to receive the raw coal. P. Cooper, in 1883, patented such a device in England.

In 1885, F. Egner suggested a somewhat similar idea, but he provided for making a rich, semi-water gas from the coke in the lower chamber, burning this with a secondary supply of air in the middle of the chamber at the base of the raw coal, thus securing a maximum temperature of the gases.

In 1889, B. Loomis also patented a similar process.

In 1890, R. Mannesman brought out an ingenious method of, first, blowing up a bed of coal with air blast until the lower portion was coked and the whole mass heated up, then circulating a small stream of water gas made by injecting steam. In this way only a portion of the gas made would be decomposed by passing through the hot coke.

1899, W. B. Johnson suggested the use of powdered coal in the fuel bed of a water gas generator.

In 1907, H. Wurts patented a combination process of first heating the coal externally to 750° F., the starting point of the distillation, and then rapidly circulating heated products of combustion over the coal, in this way avoiding decomposing the hydrocarbons formed. Most of these methods, of course, fail by decomposing the illuminating hydrocarbons.

c. Coming now to those processes which employ an externally heated gas, we find an enormous number of patents. Practically all depend on the use of superheated steam, as it has the advantage of a high specific heat, neutral action on the hydrocarbons, and ease of removal from the gas.

One of the earliest patents was in England in 1856, to Wm. C. Holmes, for the use of superheated steam, while in 1876 the combined use of retorts connected to water gas generators was patented by J. H. Johnson.

In the use of superheated steam recent work has been done by Strache and Blass, Germany, 1895. Elworthy and Lane, England, 1898, patented quite a complicated system of regenerators for perfecting the heat economy. Blass, in 1898, charged the coal directly on top of the fire.

Schell and Primrose, 1901, used this idea combined with regenerators for recovering the heat from waste gases, while, in 1905, Blass, who had probably been doing more work on this line, abandoned the attempt to externally heat the steam and connected the retort to his water gas generator directly. It has been pretty definitely proven now that with our present knowledge and means of heating steam to high temperatures and keeping it hot, we cannot hope to approach the present method of direct heat transfer through retort walls in efficiency. The type of apparatus in which the coal is distilled by the external heat from the waste products of the "blow," and internally by the hot water gas from the "run," has been extensively experimented with in the United States. Among the many processes that have been tried are the Kitson, Loomis, Humphreys-Clark and Rew, and at present Besemfelder, in Germany, is doing some work in this line.

This phase of the problem presents many attractive possibilities, especially in our Western gas plants, and the various processes have been thoroughly tried out. In general, however, from a coal gas standpoint, they have heretofore all failed. In the first place, the available waste heat from a water gas set, even under the inefficient operating conditions that formerly prevailed, is not sufficient to thoroughly carbonize coal enough to supply the generator with fuel; furthermore, this waste heat is being reduced very considerably with our improved appliances for the control and operation of water gas apparatus.

The resulting gas, unless enriched, was but a poor grade of gas, and, from a carbonizing standpoint, could not compete with even low candle power coal gas. Thus we are forced to accept the use of direct heat transference through retort walls as the most practical method in the present state of our knowledge on this subject.

Methods of Carbonization in Externally Heated, Closed Retorts.—Considering now the distillation of coal in closed fireclay retorts externally heated, there are three ways in which the process may take place:

1. Using relatively small, thin charges, which partially fill the retort, leaving a considerable free space. This would represent the usual horizontal or incline working.
2. Using a relatively large, thick charge, with a free space, as in the coke oven or chamber.
3. Completely filling a vertical or inclined retort, so that there will be no free space.

General Conditions Affecting Carbonization.—With any one of these 3 methods there are in general 6 factors that influence the course of the distillation:

1. The size of the coal particles.
2. The moisture content.
3. The actual temperature employed.
4. The volume of the charge relative to containing content.
5. The time during which the charge is heated.
6. The pressure under which the distillation takes place.

By tracing these back to their origin we may simplify them into 3 main effects, viz., time, temperature and pressure; or, in other words, under any given condition of temperature and pressure, it is the rate at which the heat penetrates the coal particles and the time that the gaseous vapors are exposed that determine the course and results of the distillation. Every chemical reaction is accompanied by a heat change. If heat is liberated the reaction is known as exothermic, while if the heat is absorbed it is known as an endothermic reaction. In general, a reaction proceeds in the direction which results in the greatest heat liberation, but under some conditions, and especially at high temperature, this does not hold, and, where the reaction may proceed in one or more directions, if the time is sufficient for the reaction to attain equilibrium, then the ratios of the products formed will be a function of the temperature employed.

Heat Absorbed or Evolved by Coal in Carbonization.—At first sight, considering the usual course of the distillation of coal and the high temperatures that are required, we should suppose that this was a good example of an endothermic reaction, and it is still so considered by some; but the work of Mahler (1), 1893; Euchène (2), 1900, and later Constam and Scläpfer (3), and Constam and Kolbe, 1906, have shown that actually the reaction is exothermic—that is, heat is liberated during the distillation. Their results calculated to B. T. U. per pound of coal are as follows:

1. Constam and Kolbe.
   Constam and Schläpfer—779 and—436 B. T. U.
2. Mahler—457 B. T. U.
3. Euchène—115 B. T. U.
4. In addition to these figures, we have the work of Barnum (4), who showed a + value of 168.5 B. T. U.

From the nature of the methods which were used, the first two results would be in error by giving too high a figure, while Euchène's figures would be too low, so that I feel we might assume as a probable mean value about — 350 B. T. U. per pound; and from Constam and Schläpfer's and Euchène's works it is seen that the exothermic nature of the reaction increases with the volatile content of the coal (5).

This means that, excluding all ulterior influences, the heat required to decompose 1 pound of coal, plus the heat absorbed in the formation of the endothermic compounds, is 350 B. T. U. less than the heat liberated in the formation of the exothermic compounds. Could we then bring a body of coal to the proper carbonizing temperature, and insulate it so that no heat could be lost, the distillation would proceed from the heat of the reaction. This is obviously impossible, however, since the gaseous vapors evolved would carry off heat, as sensible heat, from the reacting body, faster than it was formed. When we consider, however, a heat balance of the actual practical operation of carbonization, we will see that this heat given up by the reaction proper is but a small fraction of the total heat involved and may practically be neglected.

A heat balance for a regenerative bench of 8 retorts has been calculated from Euchène's work into English units, and represents about average good practice (6). The bench was giving 9,710 cubic feet per mouthpiece, with a yield of 4.91 cubic feet per pound of coal at 13.5-candle power, and was using 14.8 pounds coke per 100 pounds coal carbonized; this is equivalent to 21.1 per cent. of the coke made. The waste gases left the recuperators at 1,112° F., and contained 18.37 per cent. of CO_2, so the bench was being operated according to good modern practice. It will be noted that this balance gives a very small heat liberation from the reaction proper, due to the low volatile content of the coal used. When we study the percentage distribution of the heat absorbed as given in (7), we cannot fail to be struck by the large losses of heat in such a form that a large proportion of it should be recoverable. We have in this case 30.2 pounds of coke consumed per 1,000 cubic feet of gas made, none of the heat of which is recovered in the illuminating gas; this is almost exactly what we should expect to use for carburetted water gas where not only the heat necessary for the reaction must be furnished, but also about 70 per cent. of the total volume of the gas made must come from the fuel used.

General Stages of Carbonization.—The carbonization of coal in any retort proceeds in three general stages:

First. There is a preliminary decomposition, which begins as soon as the coal has acquired a certain fairly definite temperature; and as this stage is quite strongly endothermic, approaching, as it does, a fusion, the temperature remains practically constant until completion.

Second. The products resulting from the first stage, which consist principally of the higher members of the chain, or aliphatic series, suffer very considerable molecular rearrangement. In general, since the C-H bond seems stronger than the C-C bond, compounds containing less than 3 atoms of carbon are formed. This stage may be looked upon as a continuance of the simplification in which every distillation results. These first two stages take place almost simultaneously within the charge itself, and are both endothermic.

Third. The gaseous vapors resulting from the second stage, when evolved from the protecting influence of the actual coal particles, are acted upon by the conducted and radiant heat of the more highly heated portions of the charge proper, of the sides of the containing retort and of the superheated surfaces above the coal (or free space).

The reactions taking place at this stage are very complicated, depending as they do on the time of exposure and the temperature, and in some respects resemble a reversible reaction. The aliphatic hydrocarbons are on one hand loosening their carbon bonds and splitting off the initial members of their series, while the residues unite into more complex carbocyclic compounds. These benzol compounds under the heat influence in time are decomposed with the liberation of hydrogen, carbon and the formation of still higher ring compounds. On the other hand, the free hydrogen present reacts on the aliphatic compounds. It is this stage of the carbonization that is radically affected by the method of carbonization that is employed.

Coming now to a more detailed study of the changes that take place in these three stages, we will first take up the composition of the coal and the products formed.

Composition of Coal.

The coals used for gas making come under the general head of long-flame, coking coals. They will have a composition about as follows:

34–40 per cent. volatile matter.
Less than 12 per cent. ash.
Less than 1.2 per cent. sulphur.

From the proximate and ultimate analyses given (8) their percentage composition is, quite closely:

Carbon	70.0 — 80.0
Hydrogen	5.2 — 6.0
Oxygen	6.8 — 16 0
Nitrogen	1.3 — 1.9
Sulphur	1.0 — 2.0

Calculating the molecular composition from the ultimate analyses would yield molecules about as follows, some foreign coals being given for comparison:

West Virginia coal	C_{319}	H_{418}	O_{30}
Indian Territory coal	C_{339}	H_{476}	O_{42}
English coal	C_{438}	H_{367}	O_{60}
French coal	C_{357}	H_{281}	O_{39}

Briefly, these formulæ represent most closely the proportions in which the elements exist in the coal. This must lead us to regard coal either as a complex molecule or a complex mixture. While it is usually considered a mixture, yet we feel there are many valid reasons for considering it a complex molecule. One such reason is the close agreement between the heating values, calculated from the ultimate analyses and determined by the calorimeter; and another reason is that in general coals having a similar ultimate analyses yield comparatively the same results when coming from widely separated fields.

Composition of Products.—The products formed—coke, tar, gas and liquor—are likewise quite complex, and their complex composition varies widely with the particular treatment to which the coal has been subjected.

The coke (9), which may be considered as the carbon residue remaining from decomposition of the coal, has a composition much less complex than the coal, and may in general be of the same molecular structure. This would tend to show a ring structure in the coal itself, as in the chain compounds the C-C bonds are weaker than the C-H bond. From the tables of proximate and ultimate analyses we deduce a molecular formula as follows:

French coke	$C_{.80}$	$H_{.6}$	O_8
American coke	C_{347}	$H_{.9}$	O_{14}

Coming now to the tar (10), this we know to be a mixture of hydrocarbons which have resulted from the manifold decompositions and polymerizations that occurred during the second and third stages. Its average composition approaches that of the original coal, and this fact may indicate the probability of the coal also being a mixture. But on the other hand, if we should attempt to distil the tar as we do coal, there is a wide variation in the results obtained; being a mixture, the components are all simultaneously affected, and in general the result is an enormous amount of free carbon as soot, hydrogen, some methane, and the bulk of the tar unchanged.

We may calculate the average composition of tar from

Mahler	C_{18}	H_{12}	O
Euchène	C_{27}	H_{22}	O_3

The complete analysis of coal gas is a very difficult and elusive problem, and for general purposes has but slight value. Bunsen and Fisher, in Germany, and Berthelot, in France, have made some clsssical analyses, but their results were obtained usually by methods that are now considered of doubtful accuracy. These analyses of Bunsen, Fisher and Berthelot (11) are given, and also some determinations made by freezing out the condensible hydrocarbons. For comparison are given (12) some contemporary analyses of coal gas generated in the three usual methods practised to-day; viz., horizontal retorts, vertical retorts and coke ovens.

A sample of ordinary coal gas[1] may consist of the following gases:

Benzol homologues	$C_n H_{3n}$	benzol, toluol and xylol
Ethylene "	$C_n H_{2n}$	ethylene, propylyene, butylene
Methane "	$C_n H_{2n+2}$	methane. ethane, propane
Hydrogen	H_2	
Oxides of carbon	CO & CO_2	
Oxygen	O_2	
Nitrogen	N_2	
Ammonia	NH_3	
Cyanogen	CN	
Sulphuretted hydrogen	H S	
Carbon bisulphide	CS_2	

Strictly, the gas and tar should be considered together, as they are both evolved as vapors, and their relative composition is a question of the vapor tensions of the constituents, which in turn depend upon the temperatures to which these evolved vapors are treated. This is further complicated by the solvent action of the heavier members of the hydrocarbons. In general, the lower members of any series have the highest vapor tension and lowest specific gravity; therefore, we find them present in the gas while the higher members are found in the tars. This fact is clearly shown (10) by the decreasing ratios of carbon to hydrogen in the tars as they are deposited at greater distances from the retort.

	By Explosion and Combustion.		By Explosion.
Ill.	13.20		11.20
CO	31.10		28.50
H_2	36.45		29.65
CH_4	8.40	12.60	
C_2H_4	4.20		
CO_2	2.50		2.50
O_2	0.30		0.30
N_2	3.25		5.93

1. It might be well to call attention to the inaccuracy in any gas analysis where both the hydrogen and methanes are calculated directly from the explosion due to a residue of carbon monoxide that always remains after treatment with the cuprous chloride solution that is customarily used for this purpose. This results in too low CO and hydrogen and too high methane. For example, a mixed gas was analyzed and its composition calculated both from the explosion and combustion over palladium and from the explosion itself.

From the table given of the analyses of the gas we have calculated them into percentage by weight (13), elementary composition (14), and average molecular formula, as follows:

$$\text{Euchène} = C_{10}\,H_{41}\,O_3.$$

The ammonia liquor, of which a fairly complete analysis is given (15 and 16), may be considered for our present purpose as merely representing the water driven off and formed during the distillation.

Distribution of Elements of Coal in Products of Carbonization.—Summing up these products and using as a basis their distribution, as determined by Euchène, we would have the elements in coal distributed among the several products, as shown in (17).

Following the theory of Mills, but regarding the coal as a more complex molecule, we would have the following tentative equation to explain the result of distilling this particular coal:

$$\underset{\text{Coal.}}{C_{34}\,H_{261}\,O_{39}} = \underset{\text{Coke.}}{C_{200}\,H_{39}\,O_4} + \underset{\text{Tar.}}{C_{37}\,H_{32}\,O_3} + 5\underset{\text{Gas.}}{C_{10}\,H_{41}\,O_3} + 14\underset{\text{Water.}}{H_2O}.$$

If we calculate the heats of combustion by the Dulong formula, we would find this reaction exothermic by 2.42 per cent. of the total heat. This means that the heat of combustion of all the products from the coal is less by 2.42 per cent. than the heat of combustion of the coal, or that 2.42 per cent. of the calorific value of the coal (14,000) or 339 B.T.U. has been liberated and thus lost in the distillation.

Heat Flow into Retort and Charge, Temperature Variations and Progress of Distillation.—When we introduce a charge of coal into a hot retort the first effect is, of course, an immediate reduction of the temperature of the interior skin of the retort as the heat is absorbed by the cool charge. Since the conductivity of fireclay is very low, this supply of heat cannot be immediately replaced from the hot combustion gases, but must come from a lowering of the temperature of the body of the retort, which, in conjunction with the interior tile of the combustion chamber, acts as a "flywheel" or storer of heat. This may be a rather roundabout method of explaining the fact that, with our present facilities, we have not an unlimited supply of heat of the requisite degree to draw upon, and must, therefore, regulate to some extent the rate at which we may withdraw it.

When the coal particles are exposed to heat they acquire the temperature of the inclosing body in two ways—by conduction and by radiation. Experiments have shown that heat penetrates through the charge between 4 and 5 times as rapidly by conduction as by radiation, which argues immediately for a completely filled retort, in which case the primary transmission is entirely by conduction.

Under the influence of heat some gas is immediately evolved, even at temperatures as low as that of boiling water; in fact, all coal contains some occluded gases that may be removed in a vacuum even at the ordinary temperatures (18). As the temperature rises, however, liquid products, principally water with some tarry matter, begins to come off (19) (20a). The coal proper now seems to partially fuse and the distillation proper may be said to begin. A number of experiments (20b and 21) have been made to locate this starting point, and it may be assumed to be (21) about from 660° to 700° at the start and to remain nearly constant until the first stage is completed, when it rises to 750° to 800°, at which temperature the coal could be converted into coke.

Bornstein, who (1906) made the most extensive experiments and with the most improved apparatus, found that for a large number of coals distillation commenced at from 630° to 815°, the first combustible gas coming off between 660° and 825°. The average beginning of the distillation and evolution of gas would then seem to be in the neighborhood of 750°. We may then consider that carbonization of the first stage progresses with an isothermal line of, say, 725° F. in the coal.

We have been considering now simply that layer of coal in immediate contact with the sides and bottom of the containing vessel. When we come to consider how this heat of carbonization penetrates through the charge proper, we have a number of conditions to consider. Even if the charge were a monolith, it would require almost twice the usual time for the heat to penetrate by conduction alone,[1] so we are forced to assume that about half the heat is transmitted by the hot vapors, heating the coal as they pass through the charge. It is in this respect that we find a fundamental difference in the 3 methods usually employed in carbonizing. Charts K, L and M show the progress of the carbonization in the horizontal, vertical and coke ovens. Chart (A), showing the rise in temperature at different parts of a charge in horizontal, vertical and coke ovens, is attached, which shows this very clearly. From further charts (B and C) we see the variations in temperature that have been observed in different parts of a charge in both horizontal retorts and coke ovens. It will be seen that in the horizontal retort the heat penetrates much more quickly than in a completely filled retort, not only on account of the smaller bulk of the charge which causes less preliminary cooling, but also on account of the fact that the heated gases may circulate more freely.

The relative rate of carbonization toward the center of charge has been estimated at from 1 to 1.5 inches per hour in horizontal retorts working at a high heat, .5 inch to .6 inch in vertical retorts and .3 inch to .5 inch in coke ovens. This rapid heating then shortens the first and second stage of the distillation, and alters to a very considerable extent the character of the second stage as the products are exposed to higher neighboring temperatures. The factors that influence this rapidity are, first, the available head of heat, the size of the individual particles of coal and its moisture content. The available head of heat depends on the actual temperature of the retort walls and their heat capacity (*i. e.*, volume times specific heat), their conductivity and the heat, head, or the temperature difference between the interior and exterior of the retort.

We have very little data regarding the conductivity or specific heat of fireclay materials at high temperature and much of this data is contradictory. In general, however, we believe that the specific heat of fireclay material is not far from .20.

Euchène has calculated the hourly rate of heat transmission through a horizontal retort. His figures reduced to English units were as follows for a 350 pounds charge:

Period.	B. T. U.
1st hour	127,732
2d hour	60,109
3d hour	55,423
4th hour	43,353

Considering now that the internal periphery is 66 inches, the internal surface is 49.5 square feet, and assuming a combustion chamber temperature of 2,000° F., and the coefficient of conductivity of 11.25 B. T. U. per square foot per degree per hour, this would correspond to the following internal temperatures:

Period.	Temperature Degs. F.
1st hour	1,341
2d hour	1,676
3d hour	1,701
4th hour	1,768

which seems to correspond quite closely with observed results.

This all goes to show that if we wish to secure the maximum rate of transmission of a line of temperature of 725° F. through the coal particles, we must first bring them into intimate contact with the heated surface, and also must allow a certain percentage of voids for the calculation of the gases. The actual size of coal has been investigated with relation to its influence on carbonization. It has been shown[1] that the maximum size of a lump coal that would be properly carbonized at the center in 4 hours, to be a sphere 2½ inches in diameter. This point is important in considering the adjustment of coal crushers. From practical tests (22) it has been proven to be the case that the larger the size of the coal (when of uniform size) up to a certain point, the higher the candle feet. This we also see in the increased candle feet from ¼-inch screened coal as against run-of-mine, even allowing for the increased percentage of ash in the latter.

The principal object to be desired, then, is to quickly raise the coal to the point of carbonization and drive off the evolved gases. To a certain extent, the effect of the pressure is felt here. Experiment has shown that the effect of an increase of pressure in the retort is to considerably lengthen the time required for distillation, and of a vacuum to shorten it. This has led to the suggestion of reverting to the use of iron retorts heated to not over, say 850° to 900° F., and worked under a very high vacuum. However, it does not seem to have been carried out in practical form, though, from the results obtained in other distillations with a reduced pressure, we should expect a very rapid evolution of gas, but with slight decomposition, which would mean a high percentage of hydrocarbon of the methane and ethylene series with almost no benzol and hydrogen. The gas would doubtless be very tender, but of high candle power and heating value.

Referring now more particularly to the products of the first two stages, they have been found, as stated in the foregoing, at a temperature not far from 750° F. In general, at such low temperatures we

1. M. Gueguen, London "Journal," May 27, 1884, p. 915.

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expect the formation of exothermic compounds, such as the members of the methane and ethylene series, while we do not expect the benzols and related compounds, as these are all endothermic. We feel that these products, which doubtless consist of the higher members of the methane and ethylene series, such as hexane, pentane, butane, butylene and propylene and long chain compounds, break down even under this low temperature into simpler members of their series, following also the general law of maximum heat liberation; that is, members containing less than 3 carbon atoms, splitting off the primary members, methane and ethane.

Effect of Composition of Coal.—The elemetary composition of the coal does not help us much, except in a general way, in predicting the nature of the products. We find with increasing H, a general increase in volatile constituents. Increasing O_2 is shown by rapidly increasing proportion of CO and CO_2, while it seems also that with increasing O_2 the non-gaseous, volatile constitutents increase, which means that the tendency is to form more complex molecules. such as benzol, anthracene and pitch, which should result in higher illuminants. These facts are shown in (23) and (24). The presence of moisture in the coal, except for its depressing effect on the early temperature of the retort, does not have any appreciable effect on the gas, as it is nearly all driven off before the carbon in the coal has reached such a point that it will noticeably react with it. It does react, however, with the carbon on the sides of the retort to some extent, and tests have shown a tendency toward slightly higher percentages of CO_2 in gas while using wet coal.

Beyond the formation of the carbon oxides by water vapor, their ratio does not seem to bear any very clear relation to the temperatures employed, as they both seem to decrease with the course of the distillation; and this would argue slightly for their being influenced to some extent by hygroscopic moisture in the coal.

Effect of Heat Upon Products After Distillation.—When, now, the gaseous vapors have been evolved from the coal, and are acted upon by the radiant and conducted heat of the charge and the containing vessel, the more important changes are commenced. To understand more clearly the changes which we may expect, charts have been prepared showing the variations in the course of carbonization by the several methods: The rate of gas evolution (d), the composition of the gases evolved (e and f), the illuminating power (g), the heating value (h). In the appendix (25 to 36a) the detailed compositions are given, including the impurities, such as hydrogen, sulphide, ammonia and cyanogen. A general comment on the facts thus shown would be superfluous, as the variations will be considered in detail.

The factors that influence the third stage of the distillation, viz., the actual temperature in the retort, the time of exposure and the pressure, are so intermingled that it is somewhat difficult to give each its true value as affecting the whole. As the temperature is the active agent in the reaction, its effect will be first considered. The gas and its composition are of the greatest importance, so that we will consider primarily the changes brought about by the heat action on the hydrocarbons evolved in the second stage of the reaction.

As stated before, we feel that the hydrocarbons resulting from the second stage of the distillation consist principally of the olefine and paraffine series containing less than 3 atoms of carbon. When these hydrocarbons are subjected to temperatures from a dull red, say 1,000°, to the highest temperatures attained in a retort, about 1,800°–1,900° F., they undergo a very complex rearrangement. A great deal of work has been done on this problem, and several theories have been advanced to account for the observed results.

Marchand assumed for ethylene a decomposition to C and CH_2, when the CH_2 would be resolved into its elements. Berthelot did a great deal of work on the decomposition of the olefines and paraffines, and their polymerization into benzol and naphthaline. He assumed there was no direct decomposition to the elements, but a gradual concentration of the carbon atoms with evolution of hydrogen, until finally carbon resulted from the decomposition of a very dense carbon compound. He assumes the formation of acetylene as a primary product, and with its help elaborated a scheme of polymerization up to benzol, naphthaline, etc. His equations for the decomposition and polymerization of the hydrocarbon are given in detail in the appendix (37 and 38). He considered then that at any given temperature we should have an equilibrium established between these various products.

Lewes has later, in his work on the cause of luminosity in flame, subscribed to this idea of the primary formation of acetylene, to whose instantaneous decomposition he ascribes the light giving property of flames. He made a number of experiments on the action of hydrocarbons under the influence of heat, which are given (39 to 42). His equations for the decomposition of methane and ethylene are as follows:

$$3C_2H_4 = 2C_2H_2 + 2CH_4.$$
$$2CH_4 = C_2H_2 + 3H_2.$$

Hunt follows Berthelot and Lewes, and assumes the following reactions to occur:

$$C_n H_{2n+2} \longrightarrow \begin{cases} 2CH_4 = C_2H_2 + 3H_2 \\ 3C_2H_2 = C_6H_6. \end{cases}$$
$$C_n H_{2n} \longrightarrow 3C_2H_4 = 2C_2H_2 + 2CH_4$$
$$C_n H_{2n-6} \longrightarrow 4C_7H_8 = C_{10}H_8 + 3C_6H_6 + 3H_2,$$

and this may be held as the usual English viewpoint of those following Berthelot and Lewes.

On the other hand, Armstrong and Miller and Haber have vigorously attacked the acetylene theory, and the former found (43), from their oil gas work, that there was formed during the distillation of the petroleum oil used considerable quantities of ethylene and other normal olefines, as well as benzol and other ring compounds, but found only traces of acetylene; while in general, as the temperatures increased, the olefines decreased and methane increased.

Haber, after citing Berthelot's work, and also Lewes' conclusions, finds that there is nothing to be gained by the assumption of the primary formation of acetylene, even if the observed data warranted it, which he denies. He worked principally on hexane. The results of his experiments are given in the appendix (44). He finds two stages of the decomposition. First, at temperatures from 1,100° to 1,500° F., the lower initial members of the series are split off, forming gaseous products, while the higher residues combine to form complex molecules; he finds but little hydrogen split off and no rebuilding action on the olefines, neither does he find any evidence of equilibrium, as Berthelot claimed. At temperatures above 1,500° F., these simpler relations do not hold; hydrogen is split off, and the residue forms complex tarry compounds. He here admits, however, that acetylene may be formed, which must then polymerize into benzol or decompose into its elements, as no determinable traces of it were found; he considers then that hexane decomposes as follows:

$$C_6H_{14} = CH_4 + C_2H_4 + C_3H_6$$

Bone and Coward, who are the latest workers in this field, now endeavor to reconcile the different opinions, and have evolved a simple hypothesis to account for the observed data. They have made a number of experiments on the effect of heat on the hydrocarbons, methane, ethane, ethylene and acetylene, which are given in the appendix (45 to 50). They call attention to the remarkable stability of methane, that up to 1,470° F. it is practically staple, and that even at 2,100° F. it is only decomposed by contact with the heated surface, which is a rather striking corroboration of Tyndall's law[1] of the effect of heat on complex molecules. Their experiments on ethylene at 1,500° F. show that, while acetylene and hydrogen were formed, there was little free carbon. This is contrary to Lewes' theory, his equation ($3C_2H_4 = 2C_6H_6 + 2CH_4$), indicating that the hydrogen must have resulted from the decomposition of C_2H_2 into $C_2 + H_2$. They also show that the tendency for acetylene to polymerize is a maximum between 1,100° to 1,300°; this should furnish us with a valuable clue to the proper temperature necessary to secure the maximum illuminating value from the illuminants. This temperature has been verified in another manner in our water gas practice, where the best results seem to be obtained with temperatures ranging from 1,250° to 1,350° F. in the fixing chambers. The critical point at which acetylene decomposes into its elements is about 1,500°, which should be the theoretical upper limit to our carbonizing temperatures.

They then advance the following theory: In the case of the olefines and paraffines, the primary action is an elimination of hydrogen and a loosening or dissolution (according to the temperature) of the bond between the carbon atoms. At high temperatures, with a dissolution of the bond, nascent—may we say—residues are formed such as $= CH_2$ and $= CH$. These may pursue three courses:

a. By direct union with other residues form ethylene $H_2C = CH_2$ or $HC = CH$ acetylene; b, break down into carbon and hydrogen; c, be "hydrogenized in the atmosphere rich in hydrogen to methane," which has been shown to be so stable, and whose heat of formation is by far the highest. In the case of acetylene, the primary change will be at lower temperatures directly one of polymerization, or at higher temperatures the formation of $= CH$ residues, which

a. Decompose into their elements.
b. Are hydrogenized into methane.

1. Tyndall's law says that the effect of radiant heat is dependent and increases with the complexity of the molecules acted upon.

This theory of Bone and Coward unites to a very considerable degree the main contentions of the different workers in this field, and forms a plausible explanation of most of the observed phenomena, so we feel that at the present time it is the most serviceable. It is unfortunate that the reactions have not been studied more thoroughly from the thermodynamical standpoint, as it is only in this way that we may hope to find the ultimate solution of this complicated problem. This thermodynamic reaction between carbon, hydrogen and methane has been studied by Mayer and Altmayer.[1]

They find for the reaction:

$$C + 2H_2 \rightleftarrows CH_4$$

The equilibrium at the different temperatures as shown on the diagram given (1).

Since the water gas reaction has been investigated, we may combine these two reactions to:

$$CO_2 + CH_4 \rightleftarrows 2\,CO + 2\,H_2$$

The acetylene equilibrium has been studied by V. Wartenberg.[2]

$$2\,CH_4 \rightleftarrows C_2H_2 + 3\,H_2$$

From these three equations, and the equilibrium constants (51), we may calculate the quantities of any of the members as a function of the temperature.

Studying these results, we find they show the following several interesting features: Methane cannot exist in equilibrium with hydrogen over carbon even at a red heat, as it will, at 1,460° F. and with ample time for reaction, be completely broken down either into acetylene and hydrogen, or carbon monoxide and hydrogen; moreover, at any temperature the percentage of methane is greatly affected by the pressure, increasing with increase in pressure, and *vice versa*. To fulfill these reactions, sufficient time must be allowed for them to proceed to equilibrium, so that at the average contact time allowed we do not have this taking place; however, they show the direction in which we may expect them to proceed. They show that in our blue water gas we cannot expect to make any appreciable quantity of methane, but that its quantity will increase with the pressure and rate of make. They explain to some extent why a low pressure in the retort gives more hydrogen and a high pressure more methane. They also explain the sudden drop in methane and increase in hydrogen and carbon monoxide that are noted at the very end of the carbonizing period when the average time of exposure rises to about 60 seconds and the reaction:

$$CO_2 + CH_4 \rightleftarrows 2\,CO + 2\,H_2$$

may almost reach equilibrium. It is to be hoped that these theoretical studies will be extended to include ethylene and benzol, when we will have a firmer basis for our practical operating theories.

In the light of the foregoing theory, let us examine the actual changes that do take place in our carbonizing period. From the tables shown of the variation in elementary compositions and products formed at various carbonizing (52 and 20a and 53) temperatures, and also their effects on the tar (54), the general result of increasing temperatures seems to be a decrease in the illuminants, methane and tar, and an increase in the hydrogen, carbon and naphthaline and higher cyclical compounds. We must, however, remember the important fact that the decrease in the percentages of the illuminants, and more especially of the methane, are due to some extent to the actual increase in volume which results from the decomposition of a hydrocarbon into its elements. For example.

Ethylene $C_2H_4 = 2\,C + 2\,H_2$
1 Vol. = 0 + 2 volumes.

Methane $CH_4 = C + 2\,H_2$
1 Vol. = 0 + 2 volumes.

Acetylene $C_2H_2 = 2\,C + H_2$
1 Vol. = 1 vol. no change.

In the tars we see that the great increase in the pitch, due to some extent to the increase in free carbon, tends to mask the increase in anthracene, while the naphthas and light oils almost disappear. Carried then to an eventuality, we should have at a high enough temperature practically pure hydrogen in the gas and carbon in the tar.

Considering the analyses of gases, already referred to, showing the variation of composition during carbonization, and comparing them with the temperatures observed, it is seen that the pronounced drop in candle power occurs when the outer layers of coke have reached 1,600° to 1,800° F.; this would accord with the temperatures of decomposition of the acetylene found by Bone and Coward.

1. Berlin Berichte, Vol. 40 (1907), p. 2134. 2. Zeit. f. Anorg. Chemi. 52 (1907) p. 249.

In coke ovens, experiments have shown that samples of gas taken at different points from the edge to the center of a charge showed no benzol at the edge to .8 per cent. at the center. in other words, we do not require any free superheating space to make benzol if we can raise the temperature of the coal to 1,300° F. This has an important bearing on the course of distillation in vertical retorts where no free space exists. It was at first claimed that these retorts could not make satisfactory illuminating gas, as there was no free space whose radiant heat was held essential to the formation of the benzol compounds. With a fair American coal we have obtained as high as 15.7 candle power from our vertical retorts.

Benzol is itself stable up to about 1,650° F., but apparently even below this temperature, say, at 1,500° F., the polymerization towards benzols ceases markedly, and it is not that the benzol is decomposed, but no longer formed, that causes the decrease. Experiments on the polymerization of the benzol homologues are given (55); these show in general but slight formation of gaseous compounds except at extremely high temperatures, and then their products are principally carbon and hydrogen.

Gasification of Tar.—The foregoing leads us immediately to the question of the gasification of tar which has been very widely experimented upon.

The idea of the gasification of tar was a very alluring one to the earlier workers in the coal gas industry, and has continued to attract a good deal of attention until the last 10 years. The principal experimenters were as follows:

Montaban	1838
Lowe & Kirkham	1839
Grafton	1841
Murdock	1845
Salmon	1855
Basford	1857
Eveleigh	1869
Dinsmore	1888

At first the idea was to make a high candle power gas, but this gradually dwindled to making gas at all, continuously.

The earlier experimenters, except Lowe & Kirkham, attempted to directly gasify the tar in retorts as they would oil. Lowe & Kirkham passed the gas from the last half of a charge over a fresh charge, while Eveleigh took the bull by the horns and attempted to first distil his coal, obtain a maximum yield of tar and then gasify it.

Dinsmore, however, returned his tar as it was made directly back into the retort. His process attracted probably more attention, and was more thoroughly tried than any of the others, so it will be considered more in detail. The Dinsmore patents are as follows:

British, No. 2,096, Feb. 11, 1888, J. H. R. Dinsmore.
" " 885, Mar. 31, 1888, "
11,104, July 10, 1889, I. Carr.
10,488, June 28, 1889, J. H. R. Dinsmore.
5,145, Mar. 26, 1889, "

His idea was that the following reaction would take place:

1. The higher pffines ara → lower member (CH_4) and H_2.
2. Olefines → acetylene and hydrogen.
→ paraffine and free carbon.
3. Benzene → acetylene and hydrogen.
4. Naphthaline and anthracene unchanged.

Unfortunately, while tar possesses similar elementary composition to coal, its elements are very differently combined. The paraffines and olefines are lacking. Benzol and its lower homologues exist in but small percentages, while its great bulk consists of compounds that have been formed and are, therefore, practically stable at the temperature existing in a coal gas retort. Being a mixture, when we attempt to gasify it, therefore, all its elements are exposed directly to a temperature at which only a small fraction is unstable. The lighter members are decomposed, principally into enormous quantities of free carbon, with a little hydrogen and some methane and carbon oxide, while the heavier members simply volatilize and are immediately recondensed unaltered.

Approaching it from another viewpoint, considering that the proportion of hydrogen determines the availability for gasification of the carbon in a hydrocarbon, we observe that in coal gas we have at the ordinary temperatures a ratio of about 1H — 3C by weight, while in oil gas work we may approach 1H — 5C. Now, tar consists of about $80C7H_211O_2$, so that we could only expect to gasify some 42 per cent. of the carbon, even if it were in a state favorable to gasification.

From a practical standpoint, in the gasification of tar the enormous quantities of free carbon and pitch that had to be handled caused difficulties that proved almost insurmountable, and in 1890 Dinsmore stopped returning the tar directly, and passed the gas from 6 retorts through 1 retort heated to some 1,700° to 1,800° at the inlet, and 1,200° to 1,300° at the outlet, where it was passed out through a water jacketed standpipe in a vain attempt to overcome stoppages from dust, soot and pitch.

Isaac Carr, at Widnes, of cheap gas fame, was the last champion to give up the fight against theoretical and practical difficulties. Watson Smith made a detailed investigation of the changes in the tar, his analysis being given (56). In general, the results were as would be expected. A decrease in the light oils and an increase in the anthracene, pitch and free carbon. The solution of the problem of the gasification of tar lies in exposing it to an extremely high temperature and filtering out the free carbon, as is done in the methane-hydrogen process of Lewes and Tully, but at the present time it seems more economical to make as little as you can, as in the vertical retorts, and work that up into by-products.

Formation of Impurities.—We must consider also the other gaseous products formed during the carbonization, viz., ammonia, cyanogen, sulphuretted hydrogen and carbon bisulphide. The ammonia and sulphuretted hydrogen are exothermic, while the others are endothermic. These qualities determine their appearance in the carbonization. The ammonia and hydrogen sulphide both appear early in the distillation, soon reach their maximum, and then rapidly decline, the ammonia somewhat faster than the sulphuretted hydrogen, while the cyanogen and carbon bisulphide increase as the temperature rises.

Some tables (57 to 60) are given, showing the variation of these bodies during the carbonization, and their occurrence under different conditions of temperature and method of carbonizing employed. There has been a good deal of work done on the decomposition and formation of ammonia and cyanogen from the nitrogen in the coal, especially as to the effect of neutral gases, such as steam, on the direction of the reaction. At the present time we feel warranted in assuming the primary formation of ammonia from a breaking down of a nitrogenous ring compound, resembling perhaps the ferrocyanides in the coal during the second stage of the process. At higher temperatures the ammonia breaks down, and while the action is not reversible it may proceed in two directions, either combination in the presence of carbon to cyanogen or decomposition into the elements, as follows:

$$(N)_n P_m + NH_3 \rightleftharpoons \begin{matrix} 2\,CN + 3\,H_2 \\ N_2 + 3\,H_2 \end{matrix}$$

The decomposition seems to be a phenomenon almost entirely dependent upon contact with a heated surface, and the influence of a neutral gas only affects the extent of the reaction by reducing the chance of impact of the ammonia molecules on the heated surface and decreasing the time of exposure, water vapor and carbon monoxide slightly increase the decomposition, other conditions being equal. The critical temperatures of maximum yield seem as follows:

Title.	Degrees F.
For ammonia	850 to 900
Cyanogen	1,650 to 1,750
Decomposition into elements	1,900

But little work has been done on the sulphur compounds. The proportion of volatile sulphur in the gas to the total sulphur in the coal depends largely on the condition in which the sulphur existed originally in the coal. Generally, however, as the percentage of total sulphur in the coal increases the sulphur compounds in the gas increase. Some tests are given (61) showing how these conditions may vary with some American coals. The relative proportions of the so-called fixed sulphur compounds we find to increase with the temperature of carbonization. The average of some tests made by the German gas companies[1] showed that when using all English coal the purified gas from horizontal retorts showed 42.25 grains of fixed sulphur compounds per 100 cubic feet as against 21.74 grains for the vertical retorts, this showing the influence of the lower temperatures to which the gases are subjected in the vertical retort.

Effect of Time of Exposure of Gas to Heat.—So far we have been considering the effect of temperature alone. If now we introduce the effect of time of exposure we find another complicating effect. In any heat reaction in the presence of a temperature at which the reaction may proceed, the completion of the reaction depends upon the extent to which the molecules have come into contact with the heated surfaces in the case of simple gases, and the time during which they have been exposed to the action of radiant heat in the case of complex molecules, or if sufficient time were allowed the action would go on to completion. By varying the time, even under excessive temperature conditions, we may very considerably alter the extent of the decomposition. It is for this reason that, requiring as we do a high temperature to secure a rapid evolution of the gases from the coal, we must counteract this effect by shortening the time of contact by contracting the free space allowed for gas travel. We may approximately estimate the time of contact in a horizontal retort, as follows:

Assume a D retort, 15 inches by 26 inches by 9 feet 1 inch long, burning off 360 pounds of coal, in 4 hours, with average hourly retort temperatures of 1,200°, 1,400°, 1,600°, 1,800°, respectively, and yield 5 feet per pound. Assume also that the hourly makes are 43.4 per cent., 31.6 per cent., 18.8 per cent., 6.2 per cent. respectively. We would find by calculation that the average time of exposure is: 10.7 seconds during the first hour; 11.5, the second hour; 14.9, the third hour; 45.9, the fourth hour, with an average of 13.9 seconds for the whole charge. Referring to the chart (C), we see that as the time of exposure increases the temperature also increases. Thus, it is probable that some of the gas at the early portion of the charge has not been thoroughly decomposed, while the later portions of the charge have been over exposed to heat and decomposed. Considering again the relation of the size of charge to the cross section of the retort, we have two opposing facts, the smaller charge giving more free space and consequently longer exposure, while the more rapid evolution of gas tends to decrease this time. Furthermore, with the very small free space allowed by the large charge, we intensify the effect of the surface decomposition, which has been shown to be of the greatest effect on the hydrocarbons. Some calculations made on Verdier's experiments, as on Table (62), show that the average time of exposure remained practically the same in his last 3 cases; viz., 13.9, 13.8, 13.7 seconds, yet the candle power increased with the free space due to the lessened effect of the surface contact. Thus, we may easily overstep the economical limit of the size of charge because of this effect, in addition to the detrimental cooling of the retort, already alluded to, by so large a charge. In order to avoid to some extent the foregoing difficulties, it has been proposed to use an elliptical retort, a sketch (J) of which is given, set with its major axis vertical. This would give a small free space per unit of charge, large area of contact of coal with retort sides, and great structural strength.

Reference should be made to the proposal of Young and Glover (British patent No. 20,125, Sept. 11, 1896) for a fractional distillation, as it were, of the coal. They propose to carbonize a large portion of the coal at a high temperature, producing a rather low candle power gas, and after condensation and removal of its tar, mix this gas with the hot gases resulting from the distillation of the smaller portion of the same, or a richer grade of coal carbonized at a low temperature. In this manner they hope to absorb in the large volume of dry (relative to the benzol vapors) gas the excess of illuminating hydrocarbons present in the low carbonization temperature gas which would otherwise be deposited in the tar. This savors somewhat of the Shadbolt so-called self-enrichment process that attracted considerable attention about 1895, which consisted in returning a portion of the purified gas to the foul main at some point before the condensers. In both processes, the idea has evidently been to hold up the benzol vapors present by the excess of "dry" gas, as the benzol homologues give a greatly increased efficiency as diffused in the gas over any possible method of afterward cracking them from the tar.

Effect of Pressure in Retorts.—The question of the pressure under which the retorts should be worked is complicated by the opposite effects produced by excess in either direction. According to Wanklyn's law, the quantities of vapors are proportional to the product of their vapor tensions and vapor density, at the boiling point of the mixture. By decreasing the pressure, then, we should expect to obtain a larger proportion of the lighter benzol homologues, and facilitate the evolution of the gases from the retort; while, on the other hand, in clay retorts we should tend to draw in furnace gases through the cracks and pores of the retort, a small percentage of which would seriously affect the candle-power.

An increased pressure would, however, by decreasing the rate of evolution of the gases both from the coal itself and from the retort, tend to overheat them, causing excessive decomposition and formation of graphite. We should, therefore, seek some mean pressure

1. *Journal fur Gasbeleuchtung*, Feb. 1, 1908, p. 83.

that will just be short of drawing in the furnace gases. We may secure this in two ways: By using either a light seal and an even gauge in the hydraulic main, or a heavier seal with a higher vacuum in the main. From a practical operating standpoint, a nearly level gauge is to be desired for freedom from air leakage, yet with too light a seal the hot gases seem to thicken the tar in the main, which is very undesirable. Again, with the variations in the level of the liquor that are bound to occur in regular operation, we cannot run with too slight a margin. A ¼-inch seal seems to be the lightest that can be satisfactorily operated with under usual conditions. The use of enlarged and serrated edged dip-pipes enables a lighter seal to be carried without difficulty from the tar.

Some experiments made by A. O. Brown (63) show the effect of varying conditions of seal and hydraulic main pressure. Under whatever conditions chosen, it has been pretty thoroughly demonstrated that we should endeavor to keep them constant, and the English experience with retort house governors seems to show that their use is very desirable.

Use of Neutral Gases in Retort.—The use of a neutral gas to effect a lowering of the concentrations, and thus the decomposition, of the hydrocarbons by diluting the gases in the retort, was very extensively exploited some years ago under the patronage of Prof. V. B. Lewes, who patented a process for mixing blue water gas with the coal gas in the retort, and a great many tests were carried out with contradictory results. In general, it was found that, under proper operating conditions, the blue gas was more effective when introduced into the hydraulic main than in the retort, when it simply carried off a small quantity of the benzols from the tar, seriously decreasing its value. Later, the use of superheated steam, introduced above the charge at the back of the retort to expedite the removal of the gas from the retort, has been patented. It seems very successful in cooling down the retort. These suggestions in general have been answered by Young's work on the effect of neutral gases, where he shows that the direction of the decomposition is not changed at all, but its extent may be altered slightly.

Ammoniacal Liquor Sprayed Into Dip-Pipe.

From a practical point of operating, we feel that we should mention the use of ammoniacal liquor sprayed into the dip-pipe as a means of preventing the formation of lampblack in the bridge pipes, stoppage in the ascension pipes and thickening of tar in the main. To be sure, its use does not remove the cause, but it does remove the trouble and permits operation at high makes per mouthpiece with a minimum of pipe jumping, and entirely obviates choked mains. This process is now subject to patent application.

Summary.

Summarizing the conditions that theory would indicate and those found by practice, we have almost exactly opposed conditions. From operating necessity, the size of the retort is pretty well fixed, while the economic demands of gas made per dollar expended in fixed charges, require a high make per mouthpiece—this fixes a short, heavy charge at a high heat. Thus, we find theory demanding a light, thin charge not over, say, 2 to 3 inches thick, worked off in from 2 to 2½ hours, at a moderate temperature in a broad, flat (D) retort, while our best practical figures seem to be obtained by a charge of about 380 pounds in a 16 by 26-inch retort worked at a high heat in 4 hours. There seems to be a certain equilibrium, however, between the size of charge, the cross-section of the retort, and the temperature employed and the time of charge, which gives the most efficient results (64 to 67). However, these economic points are so dependent upon local conditions of sendout and candle power requirements, cost of labor and bench renewals and market for residuals, that their general discussion is obviously of little value.

We feel, however, it must be evident that, in any form of retort or charge having a free space, we can never expect from the nature of the process to obtain anything more than an economical mean between almost perfect carbonizing conditions at some period during the charge, and very inefficient conditions at the end, and probably also at the beginning. The value of uniformity of conditions has been strikingly shown in the operation of water gas apparatus. May we not hope for as much improvement in a method that will, to a considerable degree, secure them in coal gas work?

(To be Concluded.)

On the 21st February the electors of San Madre, Cal., will vote upon a proposition to establish a municipal gas plant.

The Progress of the Gas Industry.

[Address of Mr. A. Cressy Morrison, before the Illuminating Engineering Society, Chicago, Dec. 10, 1908.]

Gentlemen and Fellow Members of the Illuminating Engineering Society: I deeply appreciate the fact that I am a member of the Illuminating Engineering Society, and it is not only as a member that I desire to speak to you to-night, but also as a representative of a great industry.

The National Commercial Gas Association, in extending to you an invitation to hold a meeting of your Society in this building, is joined by the American Gas Institute. Both these great organizations desire that the Illuminating Engineering Society shall, as their guests, see for themselves the progress of the gas industry, as expressed by the Gas Appliance Exposition, which now fills the Armory with light and attractiveness, and the happy throng of interested people, the murmur of whose voices we can now hear. On behalf of the gas industry and these Associations, I acknowledge with appreciation the thanks which you have extended, but let me say that the invitation was so cordial that we all feel the greatest gratification in your presence, and the opportunity which has thus come to us to show our deep appreciation of the unique position which the illuminating engineer holds to-day in relation to the whole subject of the manufacture and distribution of light.

The Illuminating Engineering Society has been persistent in its invitation for the gas fraternity to join with it in its broad desire to promote the use of more and better illumination, and I feel that the industry which I represent is now in full sympathy and accord with your organization and will give it, in full measure, its support.

It has been said that your organization has proved more attractive to those who have given greater attention to electrical illumination. I think perhaps that the young men who are devoting themselves to electricity were a little quicker to understand the possibilities and benefits to be derived from more light than our industry has been, but I feel that a thorough awakening has taken place, and that the gas man will see more clearly because of the Illuminating Engineering Society, and in turn I believe that the exposition of gas progress which you are to see to-night will arouse in the minds of those who have confined themselves closely to the electric field, feelings of surprise and pleasure that their brother in the gas field has not been without inventive genius, but on the contrary that the development has been wonderful.

What is the field of the illuminating engineer? Is it not the control and direction of the octave of vibrations in the all pervading ether without regard to the source from which they emanate? The illuminating engineer should give us better windows that the glorious sun and the diffused light of day may enter, and when "old Sol" has turned the corner of the earth, the illuminating engineer should light up the darkness with these same rays which have been stored as energy, whether it be from the candle flame or the flame of the open burner, whether it be from the delicate mesh of the incandescent mantle or the glow of the carbon filament, whether it be from the vapor tube or the sizzling crater of the electric arc. It is the greatest purpose of the illuminating engineer to see that the best possible light for the object in view is used, that it is properly directed and not wasted, and to give the human eye as near an approach to the light of day as inventive genius can devise. Yours is a great profession, gentlemen, and yet you are at the beginnings of your progress. Think what the illuminating engineer, aided by the student of physics, of chemistry and mechanics, has accomplished in the last generation! Why, it is only 25 years from the candle to the illumination which you see in this great building. Think of it! Twenty-five years as against 200,000 years of intelligent humanity. If you have done so much in 25 years, what will you accomplish in the next 25 years? You will lengthen man's days, you will increase the reading of the printed page, and, by increasing knowledge, build up civilization, and you will satisfy a hunger for more light which has remained unsatisfied since the first human being feared darkness. The hungry eye cries for daylight. The best we can do is shown by this well-lighted building, wherein we give the human eye, in answer to its cry for daylight, perhaps 5-candle power per square foot, while I am told that full daylight is 60. The difference, gentlemen is your field. Oh, there is room enough until the illuminating engineer approaches daylight; until he imitates "old Sol" himself there will be room for every illuminant and need for the illuminating engineer.

In the production of light there is no monopoly. The electrician has no monopoly; the gas man has no monopoly; the manufacturer

of candles has no monopoly; the enterprising gentlemen who tapped the heart of nature and brought forth oil have no monopoly. Each illuminent has its special field. All are active competitors for the general field; and even the sun is banished where we can produce more pleasing effects by our ingenious utilization of special rays. No; there is active competition, beneficent competition, uplifting competition. The manufacturers of the sources of illumination are no longer selling current, or gas, or oil, or candles. They are selling light. Any illumination which would hold a place in the rapid pace for supremacy must be increased and perfected by the application of inventive genius, and the vibrating ether which it has set in motion must be sent in the most useful direction by the illuminating engineer. Hence, the illuminating engineer must be big and broad, must live up to his profession, must not become a partisan or the paid advocate, and to him will become indebted all the industries which supply light, for until the brilliancy of daylight is reached, the eye hunger will never be satisfied, and the more good light that is given the more the human eye will call for.

We, the great manufacturers of sources of illumination, whether it be the subtle elements which the gas man sends through ramifying pipes to the terminal unit; whether it be the current generated by the whirring dynamo and sent surging through the spiderweb of copper, or whether it be the liquid energy now purified and refined which nature has stored through the ages and which reaches its terminal point in the graceful modern lamp, are coming to realize that each has his field, that all have a common field, that the demand is unlimited and that we are competing merchants. We are retail merchants, delivering our goods, our products, from door-to-door in small quantities. We deal directly with the people, and the people will buy where they get the best merchandise As a result of this competition, light is the cheapest thing in the world. The whole family can be given a long evening of comfort for a penny or two a day, while our grandfathers to produce the same illumination would have used 60 candles. With all our inventive genius, the reaper, the thresher and the rolling mills, has there ever been much fall in the price of flour? This is but one result of competition. These great manufacturers of illuminating energy are seeking trade, just as the retail merchant seeks trade. The goods are guaranteed. The consumer is greeted as a friend. Behind the little window where the bill is paid, as well as in the office where differences are adjusted, you will find a smiling face and courteous consideration. The public is beginning to understand. The public no longer frantically turns off the light for fear of the day of reckoning. The man who buys light is beginning to deal as fairly with the man who makes it as with any other merchant. The prejudices of the past generation are being wiped out by floods of light. The public is beginning to realize that there is no other commodity which is used in the home that is delivered so promptly and in such uniform condition as the sources of illumination. The telephone is quick, but is left far behind when we romember that we have but to turn the button and light is there. We are humble merchants. We are not even permitted to enter at the back boor, but we come in through the cellar and then, like the ugly duckling, make the house radiant, not only with our illuminants, but with happiness which changes gloom to joy.

It is an axiom of the more mature that novelty is too attractive to the young man. It is fortunate for the world that innovation meets approval in the young, for in this direction lies the world's progress; but it might be said that the electrical field, because of an infinite variety, has attracted to it too many young men of the last generation. I might say that the electrical field was overcrowded, were it not for the result of the infusion of so much young blood, so much ambition, so much engineering talent and inventive mentality into electricity, which accounts for the stupendous and amazing growth, in all directions, of this wonderful development of the last few years. It seems as though in this field alone there was room for all, yet I would to-night call attention to the fact that the manufacturer of light by the utilization of gas has a much longer history than other modern illuminants, and undoubtedly, when electricity first sent its radiance to the waiting eye, the gas industry had become, in a sense, an accepted fact, almost commonplace; but the gas industry has awakened, and it, too, has developed marvelously. Aside from the fields of illumination, it has opened new avenues of utility, both domestic and industrial. Many phases of its remarkable progress will undoubtedly cause surprise to many of you, and in our beloved field of illumination you will find that with all the talent which has been utilized in the development of electricity, the gas industry is to-day fully abreast of the progress of the electricians, and, I am almost tempted to say, in some respects ahead in the race. Suppose the gas industry had had the rush of young blood instilled into it at the time electricity was born, where would it stand to-day? Do you think that it is behind where it would have been? I do. Then, gentlemen, it to-day presents a tremendous field for your ambitions. You who are competing with each other in the struggle for supremacy in an industry for which you have done so much, may find wonderful opportunities for your talent in the gas industry which has nowhere near attained the limit of its possibilities. Every member of the Illuminating Engineering Society will wisely give consideration to such an amazing opportunity.

You have been invited to examine the gas appliance exposition. It is before you. The progress of the industry speaks for itself. This is the fourth exposition of the gas industry held in the world. In 1882 in London the gas industry was for the first time exploited. In New York city, in 1897, America for the first time brought together in a single building an exhibition of gas appliances. In London, in 1904, a splendid exposition was held which showed the progress of the English gas manufacturer during the interval of 22 years. The gas appliance exposition now in progress here is the first exposition given in this country since the gas industry has fully awakened to its stupendous possibilities. It is not for me to undertake a description of this exhibition, for the exhibits will speak for themselves. The limited space on the exposition floor, already overcrowded, precluded the possibility of the exposition of the gas engine, which has now been developed so that 10,000-horse power units are not uncommon. In this field alone gas promises to become one of the world's great prime movers. The entrance of gas into the industrial field is happily well expressed. Its domestic use is exceedingly well exploited, and in your own field of illumination the latest expression of the application of ingenuity and artistic talent to gas is to be found. The exhibits and the exposition speak for themselves, and every exhibitor cordially courts your inspection.

I am asked to speak on the progress of the gas industry and yet my peroration is already on the exposition floor. It is little more than a century since the gas industry was born. I am told that the bowl of a pipe was the first gas retort, that sea coal was the source of the gas, that the bowl of the pipe was heated in the fire and that the resulting gas was lighted at the end of the stem. In this simple arrangement, we have, in theory, at least, the gas industry. The lack of time will preclude following the development of this small beginning, a development hesitating at first, sometimes practically extinguished, but which has worked its way into civilization and has become one of the greatest industries. It is useless to revert to the prejudices against the invisible substance which makes light, the grave questions which confronted communities as to the unknown dangers which might accompany its utilization, to discuss here the slow development of the proper burner, the gradual application of engineering talent, the detail of constructing tight and permanent pipes, the chemistry involved in purification, the problem involved by the expansion of the industry beyond expectation, or the difficulties which the gas man has found in defending his network of pipes from the attacks of the biting current which its electrical brother sends out but to return again.

Electricity was born at a time when the world looked at things with prejudiced eyes. In this field, science followed truth anywhere that she led. The amazing strides of this industry are due to the open mind, but science has also looked upon the gas industry with a clear eye. The prejudices of the past are buried with the past, and as a result of this progress what has the gas industry become?

I have compiled, and I believe they are presented in their entirety for the first time, some figures which give an idea of the magnitude of the gas industry. The exposition on the floor below shows you those things which are the tools and weapons of its progress, the means by which it holds the appreciation of the world-at-large, but when I tell you what the industry has become, I will make plain to you what is behind this exposition, the plant upon which this flower has blossomed. The total capital invested in gas plants in the United States is $1,600,000,000. This sum would build the Panama Canal four times, would strip Rockefeller and Carnegie of their wealth, and with Morgan added would approximate the value of the gas industry. The sum represents the exports of the United States for a year. "King Cotton" sinks into insignificance with his paltry 600,000,000. Corn, the king of crops, scarcely reaches a parity. I might go on indefinitely to show the magnitude of these stupendous figures. The gas industry serves 38,500,000 people in the United States. Nearly one-half of all the people of the United States are served with gas. When you ask me how they are served, I can answer that there is one gas meter

for every 7 people in all this 38,500,000. That is retail delivery for you. That is a house-to-house distribution. These meters each consume approximately 40,000 cubic feet of gas per annum, and the total output of gas by the gas industry in the past year was close to 200,000,000,000 cubic feet. I will leave the figures as to candle power hours to the sharp pencils which you clever gentlemen use with such facility, and will leave it to you to establish comparisons. The distance between the bowl of the pipe and that first cubic foot and the present 200,000,000,000 cubic feet per annum represents the progress of the gas industry.

I am proud indeed to appear before this body representing the gas industry, because I feel behind me a great, throbbing, enterprise which is realizing its possibilities; not a young giant, but a full grown giant, with manhood's strength, an industry which is just entering its era of greatest development.

I urge you to look well and understandingly upon the exposition. I know that you will grasp the opportunity which it holds forth with generous hand to the illuminating engineer. I know that you will find an answer to some of your difficult problems. I cannot but believe that some of the young and keenly alert minds which you possess will be induced to add the impetus of your mentality to the gas industry, and, should you do it, I assure you that the field is open and the reward is certain.

Works Economies.

[Paper prepared by MR. A. F. TRAVER, Chattanooga, Tenn., at the recent convention of the Managers of the Childs, Hulswit & Company's gas and electric properties.]

It will not be the purpose of this short paper to go into any elaborate discussion of the question of works economies, to show the actual wastages and the result in costs that occur from lack of intelligent supervision, but simply to call attention to a few seemingly unimportant details which, if given the proper attention, may result in somewhat lower operating costs.

The gas business, and in particular the works' end of it, probably presents greater opportunities for waste than any other business on account of the continuity of operation and the peculiar conditions under which it is necessary to operate. And the efficiency of this operation is almost entirely dependent on the attention given to details. The old maxim, "Take care of the pennies and the dollars will take care of themselves," applies very strongly to this business. The conditions under which different works are compelled to operate require different methods of procedure to secure the best results, and, on account of the peculiar local conditions, it is impossible to lay down any hard or fast rules which will apply to all works. While there are many methods and schemes which in one works produce the maximum operation efficiency, the same methods, if applied in another works, might tend to produce just the opposite effect, due to some peculiar conditions which do not exist in the first works. The man in charge of a plant must be able not only to study out new schemes and devices for accomplishing his ends, but must be able to judge accurately the effect which would be produced if the schemes which are used in some other works were applied to his own, and possibly change these slightly to make them conform to his conditions.

On this account I think we may safely say that the first requisite to the best efficiency in works operation in any plant is that the man in charge should have brains; second, that he should use them.

There are, of course, many labor and fuel saving devices on the market which, if installed under proper conditions, would result in savings, but as these are more or less expensive, and as the wisdom of installing them depends entirely on local conditions, I do not think it worth while to consider these in this paper.

Handling Raw Materials.—In most works it is customary to unload coal from the cars into the stock pile and to take the coal as it is used in the retort house from the stock pile. In most cases it is possible to arrange this unloading so that the stokers or coal passers can unload the coal direct from the cars. This will result in a saving on the original cost of unloading and has the advantage of saving the coal from the breaking up effect of a double handling. It is ordinarily just as easy for the men to take the coal from the cars as it is from the stock pile and, therefore, does not entail any additional work on their part. Theoretically, the maximum efficiency in this direction is attained when the coal arrives at the same rate at which it is being used. In practice this is, of course, impossible, but by careful watching the theoretical results can be at least approximated and the savings in the course of a year will be surprising. In some cases it will probably be cheaper to pay demurrage on a car for a day or two to allow this to be done.

Coal stocked once should never be touched except in cases of great necessity, as it is very expensive to trim coal and keep the stock piles in shape. If it is necessary to cut into the stock piles, arrange to do it at a point where fresh coal can be easiest stocked again when the regular coal shipments are resumed. The old theory that it is policy to work over a stock pile once every year or so has long since been exploded, and the maximum results can be obtained if the fresh coal is always used for carbonizing.

Oil.—The handling cost of oil, whether it is unloaded by gravity or is to be pumped, is so small as to be almost negligible. It is well, however, to arrange to have the unloading pipe permanent, with the exception of the connections right at the car, and to have these connections arranged so that the men can, with the least work, connect the car to the receiving lines.

Retort House Operation.—The question of bench economy, as far as fuel saving and adjustments of the bench are concerned, have been thoroughly thrashed out in papers read before the different associations, and I will do nothing more than refer these to you for consideration.

The proper arrangement of the work of the stokers, coal passers, coke handlers, etc., is governed almost entirely by local conditions, and the most efficient method must be worked out on the ground. In considering this point it is well to remember that the only real skilled work in the house is that of charging the retorts. Common labor can be used for all other work. For this reason it is best to arrange the work so that one set of men may do the charging exclusively, the common laborers doing the rest of the work, at the same time, in the operation of drawing and charging the retorts, arranging to have the doors open the minimum half of time.

Retort house tools should be kept in the best of repair at all times and a number of extra tools kept on hand in a convenient place for use in case of breakage of the regular tools. No rake, clinkering bar or other tool should be allowed to be used after it has once begun to show color, for they deteriorate rapidly at this point. To save time and cost in case of stoppage, all foul mains' off-takes should be tapped every few feet and plugged; a steam line with openings near these taps should be provided and steam hose should be hung up in some convenient place so that these two lines can be quickly connected in case of stoppages and the gas lines cleared. It is always policy to arrange to have a set of wrenches, steam hose and connections in every room where there is any probability of stoppages, ready for use at instant notice.

The proper lighting of a retort house is a question that deserves more attention than it usually receives. Most retort houses are lighted by a number of flat flame burners located on the side walls 6 or 7 feet from the floor. These lights burn a great deal of gas and even then do not accomplish the required end. A few outside gas arcs hung in about the center of the space between the benches and walls at such a height to light the top of the bench would replace a great number of these small lights, and will light the retort house much more cheaply and efficiently. The men about a gas works are usually extravagant in the use of gas, and they should be watched very closely to see that they turn out the lights when they are not in use.

In most works a considerable amount of good coke is in the ash and clinkers which come from the benches, and these are thrown away on the dump pile. By arranging a small portable screen, in such a manner that the ashes as they come from the house are dumped over it, will enable the operator to save a considerable amount of this coke, as the good coke will roll to the outside of the pile and can be picked up quite rapidly. Ashes and the clinkers from the water gas machines shonld also be treated in the same manner. In cases where the dump pile is at some distance from the retort house, the expense of hauling the ashes to the dump can be greatly reduced by the installation of a small elevated bin near the retort house, into which the men can dump their ashes. The coke teamster, with his wagon, can empty this bin during some of his spare moments.

The question of the most economical yield is another one of the subjects which have been considered by the different associations, and they have been able to come to no definite conclusions regarding this. It is, however, a question of very great importance, and one to which proper attention has not been given, as the greatest yield has

been the standard by which heretofore the operators have been judged. I will not go into this subject in this paper, for it would entail a great deal of time, but I suggest that some one of our men prepare a paper on this subject for consideration next year.

Exhauster, Condenser and Scrubber Operation.—The operation of an exhauster, after the adjustments have been made, presents very little opportunity for saving One of the most important points about the operation is to see that the pulsations are not excessive so that the retorts are one moment under heavy pressure and the next under vacuum. This is likely to be the case when the capacity of the exhauster is considerably in excess of the demands upon it. In this case it will run at a low speed and the gas pressure on the retorts will fluctuate violently. The remedy for this is to open the by-pass valve slightly and allow some of the gas to be by-passed, which will speed up the exhauster and bring the vibrations down to normal. The effect of this fluctuation on the quality of the gas is very marked and care should be taken to see that the pressure conditions are as nearly constant as possible. The amount of water used on the condensers is very often given too little attention, especially when the temperature of the cooling water is high and very near the outlet temperature of the gas. When these two temperatures approximate each other, a great deal of water can be forced through the condenser without appreciable effect, thus increasing a water bill without any return.

The overflow water from the condensers is very often allowed to run into the sewers. This can be utilized in many ways about the works, either for quenching coke, in the boilers or in the holder pit. A good way to utilize this is to put it into the feed water heater and use it for supplying the boilers.

The fresh water used in the scrubber should be limited to the smallest amount which will accomplish the desired result. It should not be the aim in scrubbing operations to remove all of the ammonia in the gas. A large excess of water is required to remove the last traces, and the ammonia thus saved will seldom pay the extra concentrating costs. In addition to this, the small amount of ammonia going forward into the purifiers greatly increases the active life of the oxide, which, to do the best work, must be alkaline at all times. The decrease in purifying costs will more than compensate for the loss of this small amount of ammonia.

Purifying Operation.—Probably the greatest saving in purifying operation can be effected by the introduction of a small quantity of air into the gas. This air revives the oxide in the foul boxes, and by reversing their order from time to time a considerable saving in the handling costs can be accomplished. In most cases 2 per cent. of air can be thus admitted without affecting the quality of the gas. Wagons or buggies for handling oxide during the changing should be as large as the men can conveniently handle. More time is usually consumed in the trips from the box to the pile and back than is used in filling the wagons. By increasing the quantity carried per trip the loss per bushel of oxide can be materially cut down. Many little devices for increasing the efficiency of the men while working in the boxes can be installed cheaply and will sometimes pay for themselves in the first change necessary.

Water Gas Operation.—Inasmuch as very few of our plants are equipped with water gas machines, it will hardly be worth while to enter into any discussion on this subject. The same applies to the operation of the ammonia plant.

Holders.—Holder operation presents fewer opportunities for any saving with the exception of the steam for heating the cups and tanks. The object toward which we are striving in heating these is to keep the water at these places just above the freezing point. It is the writer's opinion, however, that in 9 out of 10 of the holders examined throughout the country during the past winter, this water will be found more nearly the boiling point than the freezing point, thus entailing an enormous waste on account of the excessive steam consumption. The remedy for this is obvious. Many devices and wrinkles have been worked out for economically heating the holders, and a description of these will be found in the "Wrinkle" departments of the various Associations.

The painting of a holder is another point which requires careful consideration, the object being to protect the metal from the corrosive action of the liquor always present on the top of the tank water. From experiments made by the writer it has been found that red lead with boiled linseed oil is the only paint which will successfully withstand this action, and he would here recommend that as the priming coat red lead be always used. All paint will, on account of this corroding action, become mottled and dirty looking, so that the holders will require a painting once each year or two for looks' sake. Almost any paint can be used for this purpose after a good priming coat of red lead.

Boiler Operation.—Steam cost at a gas works for ms one of the most important costs of the operation. As far as the actual boiler practice is concerned this has been covered in papers read before the different gas associations and engineers' associations and will not be reviewed here.

Probably the most important saving of a gas works lies in the ability to use breeze for boiler fuel. If the boilers are not working under an overload or near their rated capacity the burning of breeze is comparatively simple; but as the load on the boiler increases this becomes more and more difficult. By the use of forced or induced draft on the plant this can be accomplished in all cases, except possibly just after the fires have been cleaned out, at which time some coal may be needed. The necessity for having all steam or leaks properly repaired is obvious.

Tools.—Most works' operators are laboring under the delusion that the fewer tools about a works the better on account of the high first cost. They will oftentimes allow a man to spend more time looking for tools than it takes him to do the job. It is the writer's opinion that the more tools about a gas works the better, provided they are looked after carefully and not allowed to become lost. The importance of good tools and plenty of them cannot be overestimated.

General.—The importance of keeping the works and buildings in the very cleanest condition at all times is one of the most important factors leading toward low gas costs. It may seem foolish to say that a clean yard or office will reduce the retort house cost, but it is nevertheless true. No man, regardless of his position in life, enjoys working in a dirty place. A small amount of effort and money spent in keeping the works clean will be amply repaid by its effect on the spirits of the men, and to accomplish this every facility should be given them in the way of brushes, combs, books and extra help, if necessary.

Lessons I Have Learned from Experience.

[A paper prepared by MR. T. J. WEBER, Consulting Engineer, for the Child, Hulswit & Company's Convention of Managers.]

Fourteen years ago I received my first practical experience in this country with the Central Union Gas Company, of New York city. The first lesson I received was very deeply impressed on my mind, and has ever since acted as a guide in my actions.

Through relationship to a high official of the Consolidated Gas Company I secured a position with the Central Union Gas Company, which is the experimental station of the Consolidated Gas Company. In consequence, I expected to receive quite an important position, and reported for duty one Monday morning, all dressed up. The General Superintendent, who had been previously advised of my coming, received me with a smile on his face, and, without any questions, assigned me to the general foreman of the manufacturing department, who in turn introduced me to the retort house foreman, with instructions. I was very much impressed with the systematic way in which each man attended to his duties, as well as with the perfect cleanliness of the plant.

The retort house foreman sized me up in a few moments, and gave directions to a man to lend me a pair of overalls and old shoes; he then handed me 2 pails and a scraper, and, in company with an experienced man, I was put to work in cleaning the hydraulic mains. My pride dropped below zero; if this was the best they could do for me my future did not look very prosperous. I stood this for 1 week, when I threw up this job in disgust and did not even go after my pay envelope. A few weeks passed, and I was called to the office of the official who recommended me, and what he said to me was "good and plenty." I was asked how I ever expected a responsible position as long as I did not learn all the details of the business by actual work, and how I could ever exercise executive ability, not knowing the elements of such work and the results that depended on same. During all his conversation I felt like "thirty cents," and he finished up by saying: "No, my boy, it is only by actual work and training that you can acquire the necessary knowledge and prepare yourself for a better position."

It was my first lesson, and I considered it a hard one; but it served its purpose. The next day I again reported at the plant, with a better spirit and with a firm determination to stick it out under all circumstances. I was prepared with overalls and a full dinner pail, and I have been a happy man ever since.

In the 5 years that I served with the Company I advanced to the position of Acting Superintendent of a plant with a sendout of 2,000,000 cubic feet daily; and up to this day I have not seen a plant with a better system of organization and discipline. Every employee was enthusiastic in his efforts to produce results, and harmony prevailed among all.

In November, 1898, I received word from my brother that the city of Vienna was constructing a new 1½ billion cubic feet municipal plant, and he had an opening for me where I could become actively engaged in the construction of the bridge division. This bridge is now equipped with one 48-inch and one 36-inch main and was built exclusively for this purpose over the Danube canal; there being no traffic of any kind over this bridge. In this I saw a splendid opportunity for obtaining further valuable knowledge and experience.

In December, 1898, I left for Europe, and on my way over laid out my plans. In a way, I was pretty strongly Americanized, and with the experience I had acquired with the Consolidated Gas Company, I had in my mind that I would show them a few things over in the old country, and how we accomplish things over here.

On January 1st, 1899, I reported for duty, and was considerably astonished when I was assigned not even as foreman, but on the regular construction gang. I must admit it was not I who showed them, but they who showed me, and another lesson was added to my experience.

In order not to take up too much time by going into details, I will only mention that after 6 months the work was completed, and I held the position of Division Superintendent, which position entitled me to a year's course at the Technical Gas Institute, at Karlsruhe, Germany, provided that I wished to do so. I was only too glad to take this opportunity, as they had demonstrated to me fully that the gas man in the old country could show us a few things over here.

The Gas Association in Europe includes almost every country over there, and consists of experienced men with great executive ability and qualifications. No man can become a superintendent or manager without passing the required examinations before a Board of Governors elected by the Association, and I can assure you that when a man receives his certificate of qualification he is well prepared for any position that may be tendered him. No pull of any kind or relationship will secure any position for him unless he has demonstrated to the Examining Board his qualifications both technically and practically.

In August, 1901, I completed my course at Karlsruhe, after which I returned again to the employ of the Consolidated Gas Company in New York. I returned a man wiser in experience and the highest esteem for the gas fraternity in the old country.

In 1905 I went west and took charge of a gas and electric property having a yearly sendout of 35 millions. Here, again, the same lesson came back to me, for the plant had been let go to the bad on account of lack of knowledge, discipline and organization. It does not take very long to put a plant in a deplorable physical condition; but to put it back on its feet again, where good results can be obtained, is a very slow and tedious task.

After serving 3 years with that Company, I became connected with this organization, and what lessons I have learned here I need not illustrate to you, as each of you, individually, knows how much work we put in, in order to accomplish the desired results, and I do not hesitate to thank you all, and your employees, for the hearty cooperation you have accorded me in this direction. And especially so, as it was during a time of general depression, and many a hard nut had to be cracked in order to cut down operating expenses and put the plants in first-class physical condition. Once more I can say here to you all, and I have no doubt that everyone of you will bear me out in my statement, that all of our plants are in A No. 1 physical condition, so that every stockholder may well be proud of his connection with them, and not only from the physical but the financial standpoint, as from month to month we are cutting a chip from the ahead, sometimes under very adverse conditions, which we are going in the right direction. As mentioned before, it is a slow and tedious task, but in our business we are hardened to knocks and rough roads, and the man who is willing to plug ahead, sometimes under very adverse conditions, which we are all bound to have at times, is the man who will succeed.

It takes nerve, backbone and sterling executive ability to cut loose from a clock-winding organization, bound in red tape to the minutest unessential details. It is, therefore, an axiom that the man who has not this nerve is not a natural born manager. The true test of the good manager is the actual amount of work that he can deputize to his subordinates whose fitness he had the judgment to discern. When once these persons are selected, they should be permitted in a measure, to "work out their own salvation"—under reasonable scrutiny, but not under an espionage that restricts all play of original effort, or makes a worker a mere perfunctory, self-acting machine. This sort of policy takes all the ginger out of the average worker; it dulls the edge of his mentality; only the exceptional man can rise above these conditions. He kicks off the restraint and seeks a larger field where there is greater latitude for the development of his innate powers.

The man who holds on doggedly to the smaller work never grows in his business; broader opportunities are shut out; the work degenerates. The man who entrusts his smaller work to a subordinate, and then hangs around all the time and practically does that work himself, does an injury to himself as well as to his subordinate.

Make your employees carry a certain amount of responsibility and hold them down for these results; let them be a part of the organization. Hold monthly meetings with your employees and discuss with them the problems of the day. You will soon find out that you have men in your employ who are seeking and are eager for such information, and in turn will bring points to your attention that will ultimately lead to big savings for the company. At the same time, these employees are no longer ordinary laborers in your eyes; they become educated in our business to such an extent that these men will prove a valuable addition to our institution and will be putting themselves in line for promotion. It will also keep you in close touch with every man. You will learn the character of your men, and early discover a man who is liable to create friction that will produce a faction in the force, which will bring bad results and endanger the discipline of the whole organization. Weed him out; promote one of your own good men to his place, and this kind of man will prove to you that he has his heart and soul in his work, and, in cases of emergency, will go through fire for you.

A successful manager will always keep his eye on the indicator, and will practice such economy that will bring the right kind of results. He will allow no expenditure of any kind to go on before he is entirely satisfied with the importance of the same. His plant is kept in a first-class physical condition from day to day; every piece of apparatus and machinery receives careful attention; leaks of any description are unknown; labor, material, repairs, etc., are properly classified and charged; construction items kept as low as possible, and nothing charged to this item which by right belongs to operation, in order to make a good showing. By doing otherwise, you are not only deceiving your employers, but you are deceiving yourselves. You are losing control as well as confidence in your own selves, which is the first step to downfall.

Correspondence.

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Regarding the Accuracy and Dependence to be Put on the Jet Photometer.

SAN FRANCISCO, CAL., December 22d, 1908.

To the Editors, AMERICAN GAS LIGHT JOURNAL: Regarding criticisms of jet photometers in general by the Bureau of Information of the American Gas Institute, the answer to question No. 15, as published last September, is misleading and incorrect. Evidently it was written by someone who does not understand photometry, and certainly knows little about gas. One statement, "The lower the candle power of coal gas, the lower will also be its heating power," is very misleading, as I have personally analyzed and tested coal gas made by the Lowe coke oven process, which was non-luminous—that is, would give no candle power when tested by a Bunsen bar photometer, yet the gas contained 700 B.T.U. per cubic foot, which is a greater heating value than any coal gas made in the East.

I have never claimed that a jet photometer was an infallible instrument for measuring candle power, any more than a candle is a reliable standard for determining the intensity of light. Furthermore, a jet photometer is no better than the man who uses it, and there are hundreds of gas engineers who place confidence in my photometers because they test them frequently by the Bunsen bar and know themselves that they are comparatively correct. I suppose it would be fair to say that an observation taken of the sun is the only reliable means of determining the hour of the day; still, we poor,

benighted individuals keep on using watches, costing from $1 upwards, and if they are of the dollar kind, we look after them frequently and check them up by some other fellow's chronometer. This is all I claim for the Jones' jet photometer.

Differences are apt to happen where photometers are carelessly cleaned, and the hole in the bell is reamed out with points of wood, which I have frequently known to have been done. There is no reason why the instrument should not be as nearly correct as a bar test taken indiscriminately by an itinerant gas examiner. I have always claimed that a carefully adjusted jet photometer, kept clean and frequently tested, was less apt to go wrong than a bar test with the personal error (amounting in some instances to 2 candles) of a person taking a Bunsen bar test.

Far be it from me to cast any reflections on the poor, old bar photometer, which is our readiest means of finding candle power, and we surely depend upon it to adjust our Jones' jet photometers; but the crudeness of our methods of taking candle power is certainly amusing.

The candle as a standard is variable and unreliable, and other known standards are little better, while the burners used for developing the light from the gas are even worse. The poorest Welsbach burner which we use will develop over twice the candle power per foot of gas as the best standard Sugg burner, and in some of our cities the regulations governing the taking of candle power, state "That the burner best adapted to obtain light for domestic use is the proper burner to use."

In Massachusetts, when Mr. C. W. Hinman was State Gas Inspector, Mr. Hinman took the trouble of comparing the Jones jet photometers with his findings on the Bunsen bar in the different cities and towns in the State, and the error was usually in fractions of a candle; first one way, then another.

Do not attempt to compete with the Bunsen bar photometer, nor to supply an instrument which is always an accurate measure of candle power, but that is comparatively correct and always convenient. That photometers should be cleaned and tested from time-to-time, the same as any other instrument of precision, and with this ordinary care, the jet photometer is more valuable for the busy man, and particularly in small works, than the Bunsen bar. E. C. Jones.

Items of Interest
FROM VARIOUS LOCALITIES.

The yearly reminder of 1909, by the Western Gas Construction Company, in the shape of its annual calendar, is at hand. It is a very handsome specimen of the art of the limner, an excellent study of the craft of the typographer, a worthy specimen of the printers' best effort. The back sheet carries an illustration of "The Poet 'Mid Congenial Friends," and this is the way the "picture" moved one of our friends to remark: "A gentleman's house in the country; a company of friends. The snug comfort of an open fire; the satisfaction of being free to indulge in reverie or in conversation with good neighbors. These things delight us in books or pictures, because they are what most men desire for themselves in their lives." Now, if the calendar so moved one of our ordinary business friends, how great might its power be over one more easily moved? Write to Mr. C. H. Printz, of the Company, for the time marker, and then discover for yourself.

The Goldberg Gas Fixture Company, to manufacture gas fixtures, brackets and lamps, has been incorporated by Messrs. B. Rattner, M. Blum and Lena Goldberg. It is capitalized in $5,000. This concern will not disturb the existing makers of fixtures; for some time, at least.

The records of the Boston Consolidated Gas Company show that the numbers placed on service for July, August, September, October and November of 1908 numbered 753 more than the number placed during the corresponding months of 1907.

Mr. H. A. Ferandon, Secretary of the New Orleans (La.) Gas Light Company, has notified the shareholders that a dividend of $3 per share has been declared, payable to shareholders of record, December 31st last, on the 15th inst.

"L. M. M." incloses the following from Chicago, under date of Dec. 24th: "The right of the Peoples Gas Light and Coke Company, of this city, to construct a large storage holder, on 64th street, between State street and Grove avenue, has been upheld by the Appellate Court, which opinion sustains in every instance the decision in the case handed down some time ago by Judge Honore in the Circuit Court. A resumé of the case is this: Property owners in the neighborhood objected to the erection of the vessel. Peter Bartzen, at the time Building Commissioner, issued the neeessary permit, and later on threatened to revoke it. For a time work was stopped by the interference of the police, and an action by the Company for a permanent injunction from such interference was instituted. The last Court held that as less than two-thirds of the street nearest which the holder is to be built is residential the complainant is not required to obtain a frontage consent. The Company owns a majority of the frontage on both sides of the street."

The Port Jervis Electric Light, Power, Gas and Railroad Company is before the Public Service Commission, Second District, New York, on an order requiring its proprietors to show cause why it should not be required to comply with recommendations made by an Inspector, whose report declared for the immediate improvement of the Company's gas and electric plants.

At the last meeting of the Georgetown (Del.) City Council, and only after considerable discussion, it was decided to go on with the proposition to engage the taxpayers on public account in the supply of water and gas.

The owners of the Marengo (Ia.) gas plant have wisely expended $5,000 or more on refitting their "cold process" plant to a plant of the modern water gas type. It will be better for both proprietors and patrons.

On the 18th of December last the Chemistry Class, Boise (Idaho) High School, visited the plant of the Boise Gas Light Company, and made a thorough inspection of the same, under the guidance of Manager Lamson. This visit is an annual one, and the boys subsequent to it are expected to write an account of the things they saw and were told connected with their journey through the works.

Just think of that renowned exploiter of odd-lot gas stocks getting cornered at or in his own specialty! At any rate press despatches dated Hartford, Conn., the 23d ult. are to this effect: "Acting under a complaint for an accounting before a judge of the Superior Court, Sheriff Latham and deputies to day attached every available possession of Lafayette E. Pike, a promoter and stock and bond broker, of Hartford. In the suit B. Van Steenbergh, of Goshen, N. Y., the plaintiff, alleges that 2 years ago Pike agreed to dispose of the stock and bonds of the Electric Gas Company of America, that Van Steenbergh might erect for the city of Butler, N. J., a plant to manufacture gas under a new process, of which Van Steenbergh is the inventor. Serious charges, including the misappropriation of one block of stock valued at $52,900 are alleged in the complaint."

The Hartford (Conn.) Gas Securities Company has declared a regular dividend of 4 per cent. on the preferred stock, a dividend of 4 per cent., regular, on the common stock, and an extra dividend of 2 on the latter. All were made payable the first inst. The stated payment is the first extra dividend declared on the common.

It is quite certain that a modern gas plant will be constructed in Ogden, Utah, this season. Mr. Henry R. Lee, who looked over the present condition of affairs in Ogden for the parties interested in reviving Ogden's gas supply, hands in a report very much in favor of the proposition.

The Western Gas Construction Company has secured the contract for the erection in Enid, Okla., of a complete oil gas plant. The latter is in the chain of properties operated by Messrs. H. M. Byllesby & Co., of Chicago, and the coal gas system has heretofore been favored in Enid. Owing, however, to the very low price at which good crude oil is now selling in that locality, the change was determined upon. The contract calls for 2 complete sets of oil gas machinery, each 5 feet 6 inches, with auxiliary apparatus for handling lampblack, an oil gas washer, a 20,000 cubic feet capacity steel tank relief holder, and a Roots exhauster with intermediate yard piping. Each of the plants will have a capacity in excess of 200,000 cubic feet per day,

wherefore, it seems that the Company is well discounting the need of additional construction work in the near future.

THE residents of South Wilmington, Del., will be supplied with gas before mid-month from the plant proper of the Wilmington Gas and Electric Company. About 4 miles of mains had to be laid; also, a fair-sized storage holder.

THE Rochester (N. Y.) Railway and Light Company is evidently intending that its customers shall have the means of learning how to read their gas meters, for recently it secured a goodly space in the advertising columns of Rochester's leading newspapers to inform the public that the Company had distributed 30,000 cards of instruction in respect of making meter reading easy; and that it stood ready to distribute as many more in the cause were it shown that such a distribution was at all necessary in the premises.

THE proprietors of the Grand Rapids (Mich.) Gas Light Company have increased their capital stock by emitting a new lot, equalling the former stock less perhaps 18 per cent.

AGAIN are we told that Mr. Burdette Loomis will begin work on the construction of a gas plant for Waycross, Ga., "shortly after January first." Perhaps; certainly, though, it will be "after the first."

MR. E. C. PEEBLES, who recently resigned the position of Superintendent to the North Adams (Mass.) Gas Company, has been appointed Superintendent of the Chicopee (Mass.) Gas Company, vice Mr. Chas. H. Nutting, who resigned in order to take service with a gas engine manufacturing concern.

THE proposition to purchase the Georgetown (Del.) gas and water plants for operation on public account, grows steadily in favor, and it is not at all unlikely that the Council at its meeting this month will decide the matter in favor of such operating.

NEWPORT, CAL., wants a gas supply, and the authorities are disposed to offer fair terms in connection with the necessary franchise.

A CORRESPONDENT in Cambridge (Mass.) writing under date of the 25th December, incloses the following: "One day last week a negro named Alexander Miller was arrested by the police as he came out from the premises, No. 764 Main street, this city, the apprehension having been made on the charge of grand larceny. For some days a negro was known to have called on various house owners, showing the occupants a gas saving valve which he claimed could be easily attached to the house riser and that its operation would effect a great saving in the quantity of gas consumed. Quite a number permitted him to install the device, which he usually did by disconnecting the outlet of the meter 'and inserting the necessary valve.' His usual price was $2.50; but he frequently took less. Some of the more curious of his patrons investigated the 'valve' insertion, only to prove that a piece of gauze had been placed in the pipe. I just thought I would let you have the facts, so your readers might be ready for visits of a similar nature, perhaps not right away from negro Miller, who I imagine will remain quite a while in Cambridge, and not as a free agent."

THE Home Gas and Electric Company will continue to do the public lighting of Redlands, Cal., for another period of 5 years, to date from the 1st inst. The rates paid are: $4.50 per month each for arcs, and 57 cents per month for incandescents—all of the electric type. A moon table is followed in Redlands.

THE Citizens Gas and Electric Company, of Council Bluffs, Ia., will increase its capital in the sum of $100,000.

THE repairs to the gas plant at Little Rock, Ark., which was badly damaged by an explosion some weeks ago, were completed in ample time for the service to be fully resumed Christmas eve.

THE appliance showrooms of the Laclede Gas Company, St. Louis, Mo., veritably took on a holiday appearance the third week of last month. From Monday, December 21st to Thursday the 24th, it gave away thousands of biscuits, cookies, wafers and other "light things" that were made edible on the huge gas range that was in operation in full view of those who cared to watch it. Christmas eve was marked by an extra distribution of aluminum burner tips and great bushes of holly stems. Everything looked well in the arrangement, and the numerous visitors attached to the Laclede's well appointed offices and showrooms were not at all backward in close inspection of these parts of the domestic economy of a Company, the average glance of visitors theretofore having been made chiefly in front of the receiving tellers' window.

MR. WILLIAM J. CALLANAN has been succeeded as Superintendent of the Auburn (N. Y.) Gas Company by Mr. George Fisher. Mr. F. O. Cheney, Mr. Callanan's predecessor at Auburn, is now in charge of the Huntsville (Ala.) plant.

A CORRESPONDENT in Easton, Pa., forwarded the following some days ago, in fact, in ample time for our issue of last week; but pressure on our space was such that it had to be omitted. However, it really loses none of its values through the delay, for that which it teaches will easily be with us for a long time. The inclosure reads: "Possibilities of a resplendent Easton, with the ordinary commercial light turned on, were shown before a large audience of representative citizens in Heptasoph Hall, Friday evening. It was not a conjurer's trick, but a simple talk on the development of cities by the development of its illumination facilities, which was given by Mr. George Williams, of New York. The speakers were introduced by Mr. Fred. R. Drake, who acted as Chairman. Many members of the City Council came to the lecture hall after the Council meeting had been declared adjourned. In point of interest the pictures themselves were unique in that all of them—130 or more—were taken at night in different cities of the country. They showed the electric sign, small, large, straight, curved, angular, great blobs of illumination standing out against the darkness of inky sky. Few were prettier than the illumination scenes of the far-famed 'Boardwalk' of Atlantic City. Many scenes were shown of New York, including the Singer building and Great White Way. Several views of State street, Chicago, were also given. More interesting, because of coming to a class in which Easton may have a chance to be enrolled, were the dozens of slides of smaller cities of the United States. These included views in Mongomery, Ala.; Birmingham, Ala.; Memphis, Tenn.; Cincinnati and Dayton, O.; Syracuse, N. Y.; Scranton, Pa., whose many flaring lights were a surprise to such as have not been to the big coal town lately; Auburn, N. Y.; Denver, Col.; Spokane, Wash.; Lincoln, Neb.; Marion and Muncie, Ind.; Rockford, Ills.; Canton, O., and Wheeling, W. Va. The number and variety of business houses which are shown in these pictures embrace almost every line of merchandising and industry, banks, stores, manufactories. hotels, etc. The attractiveness of a town to its own people and to strangers when its streets are brilliant and light as day at night was a strong lesson told by the camera and speaker. An interesting visitor at the meeting was T. E. Valentine, of Atlantic City, who brought with him a design for the gigantic frame and light which are to be put up by the Easton Consolidated Gas and Electric Company. The sketch designs were conned with keen interest and the matter of the proper slogan for progress to be raised by Easton was much talked over. Mr. Valentine has designed many spectacular light shows at the expositions and the Great White Way, New York. In addition to the illustrated lecture a talk on the 'Progress of Electricity' was given by Francisco Laurent Gadinez, Consulting Engineer and expert, of Havana and New York. Mr. Gadinez spoke of the wonderful improvement in the science and use of electricity since the days when it was comparatively a luxury. The X-ray and wireless telegraph, two most expensive discoveries, have been brought to everyday application at reasonable cost. New York State alone, he pointed out, manufactures enough electrical energy to run all the railroads and lighting of England, France and Germany combined, and one generating machine in New York city manufactures sufficient current to run all the railroads and lights of Switzerland. These are the days of big things in electricity in this country, and the harnessing of Niagara Falls is the thing which gives New York State such a big lead on volume of electrical energy."

AT the annual meeting of the North Attleboro (Mass.) Gas Light Company the officers elected were: H. F. Barrows, Ira Richards, W. Melcher, E. A. Codding, Ira Richards, Jr., and Ira Barrows; Treasurer, E. A. Codding.

THE AMERICAN GAS LIGHT JOURNAL

The Market for Gas Securities.

The descision was not handed down this week, as was confidently expected; but what does a week, more or less, amount to, seeing that years have been put in the case? Quotations for Consolidated and Brooklyn Union are lower, but these changes have to do more with speculative market conditions than anything else.

Peoples, of Chicago, keeps going up serenely. Don't overlook these shares. There is good and quick return in them to a certainty. The bond market is quite active. The Doherty-Denver securities, too, are surely making good. Even now they have exceeded the values set for them a year ago by the associates of that clever gentleman.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

JANUARY 4.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated Gas Co.	$73,177,000	100	163½	164
Central Union Gas Co.—				
1st 5's, due 1972, J. & J.	3,000,000	1,000	98	101
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	130	160
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	102½	103
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	100	101
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	86	91
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	147	148
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91¾	92
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	1¼	1⅝
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,880,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	20,500,000	100	89¾	89⅝
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90¼	91
Preferred	3,026,500	100	75¼	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	—	—	74½	75
Detroit City Gas Co	5,000,000	50	—	50
" Prior Lien 5's	4,619,000	1,000	97	100½
Detroit Gas Co., 5's	381,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104⅜	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	112	113⅛
" Bonds, 5's	10,500,000	—	103	103⅜
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis.	10,000,000	100	—	100
Preferred	2,500,000	100	60	90
Bonds	10,000,000	1,000	104	104½
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	87¾	88
Preferred	25,000,000	100	88	89
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	104½	105
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104⅜	105⅛
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	—
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington (D. C.) Gas Co.	2,600,000	20	350	351½
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	230	—

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., N. W. CORNER BROAD AND ARCH STS., PHILADELPHIA, PA., Dec. 9, 1908.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Jan. 15th, 1909, to stockholders of record at the close of business, Dec. 31, 1908. Checks will be mailed.

1749-5 LEWIS LILLIE, Treasurer.

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As Superintendent or Manager of Gas or Electric Light Plant, or Both.

Graduate of Cornell University in mechanical and electrical engineering. Actively employed in combination company since 1906. References from leading engineers and managers and others familiar with my work and results. Open for employment after Jan. 1, 1909.

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1751-2 Address, "C. W.," care this Journal.

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In January, 1907, the above company installed a Rotary Meter of 60,000 cubic feet capacity per hour.

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These meters are shown in the above illustration.

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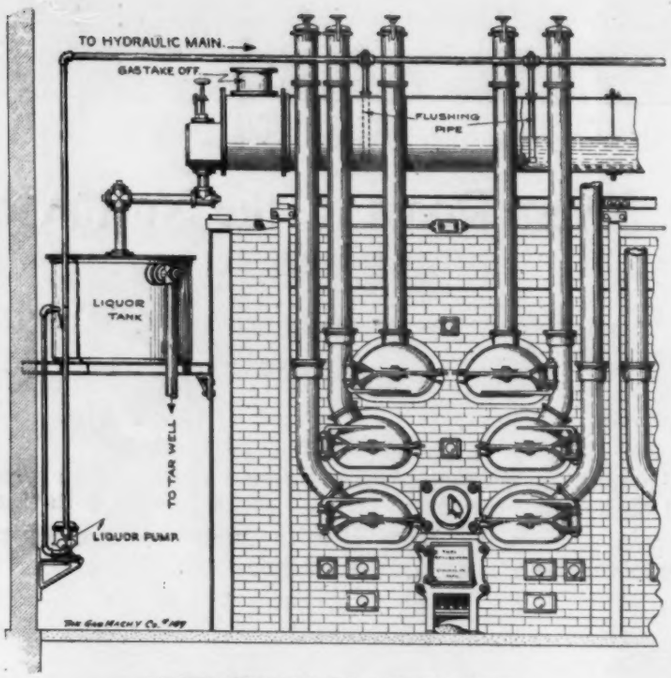

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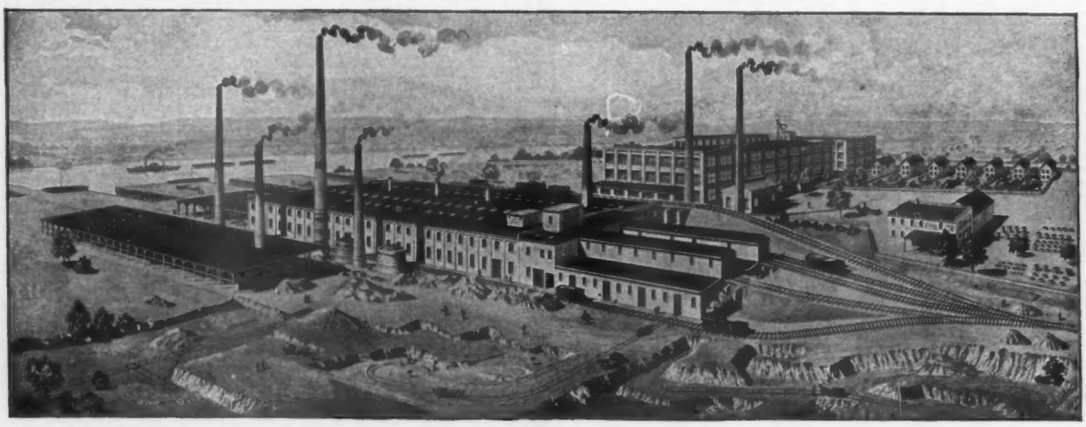

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FREDERIC J. MAYER, General Manager.

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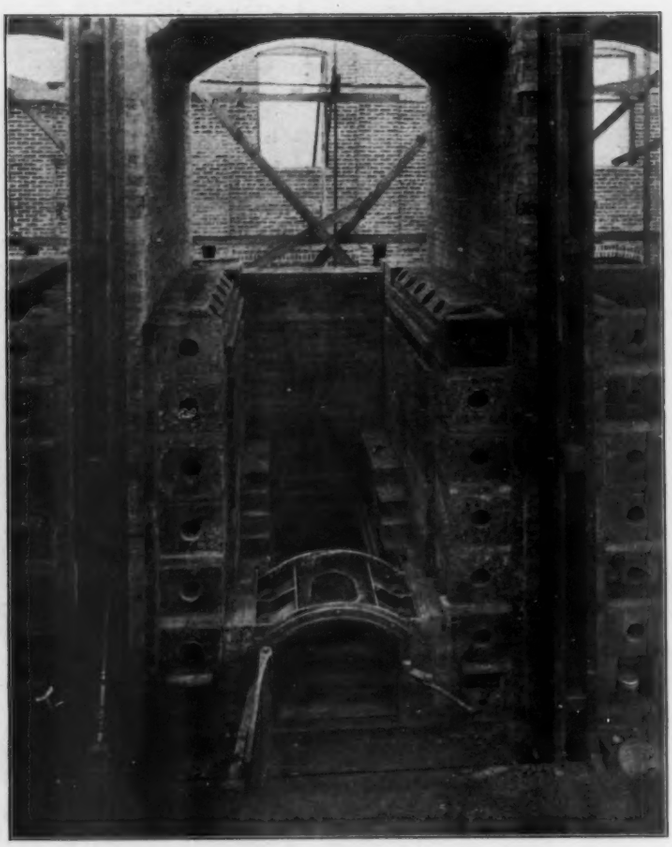

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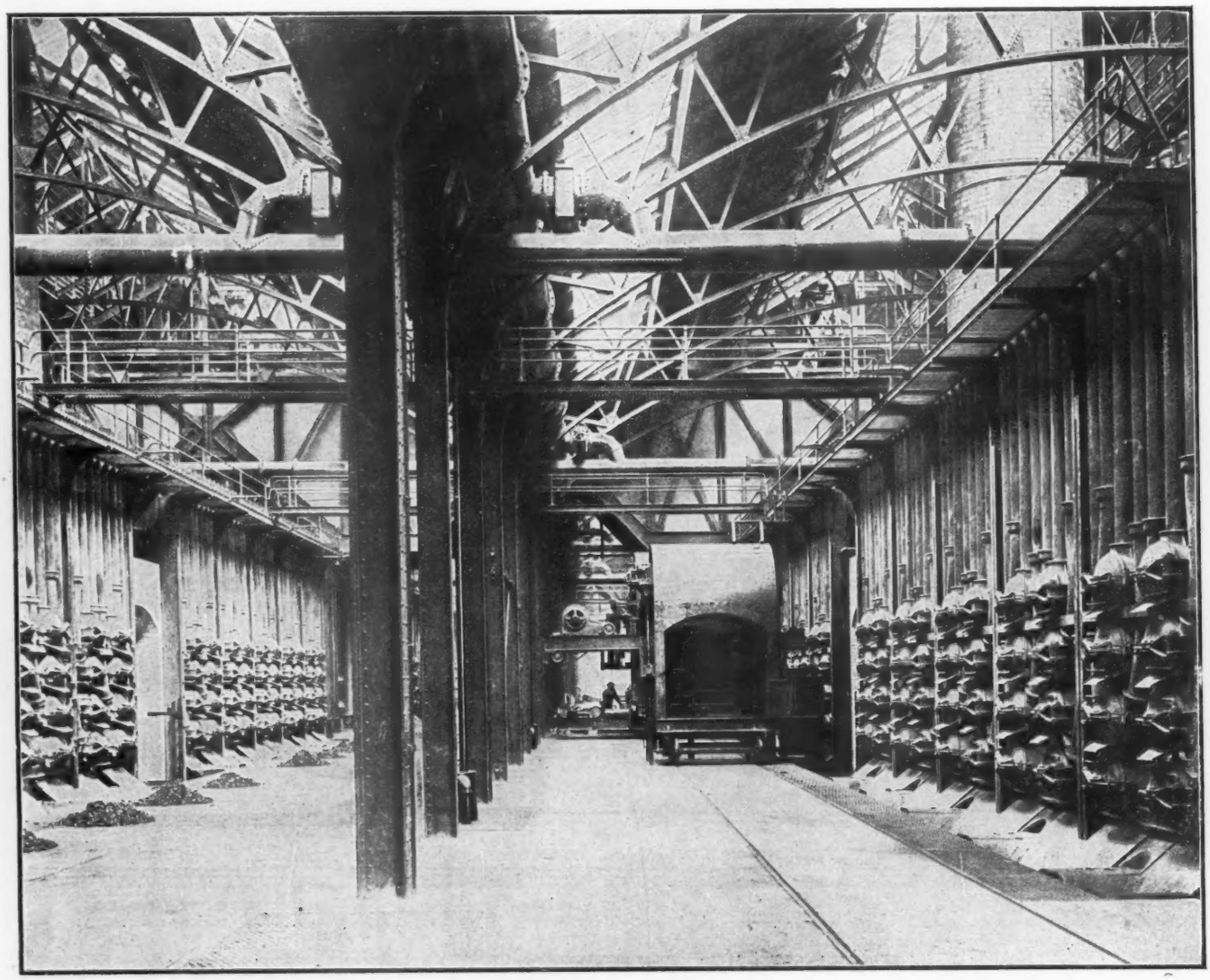
Retort Houses and Conveying Machinery.—We also build Retort Houses, Coal and Coke Conveying Machinery. Plans, specifications and estimates cheerfully furnished.

CORRESPONDENCE SOLICITED.

ALL CONTRACTS MADE AS OF ST. LOUIS.



Eleven Millions Capacity in One Retort House.

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PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

COMPLETE COAL GAS PLANTS.

CRUSE-KEMPER COMPANY,

Gas Engineers and Builders.

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GAS ENGINEERS & BUILDERS OF GAS WORKS

BENCH WORK

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PRIMARY AND SECONDARY CONDENSERS FOR FRESH OR SALT WATER

ISBELL VALVES SPECIALS

TAR EXTRACTORS

P. & A. TAR EXTRACTORS FOR WATER GAS

ROTARY AMMONIA SCRUBBERS

SHAVING SCRUBBERS PURIFIERS STREET GOVERNORS

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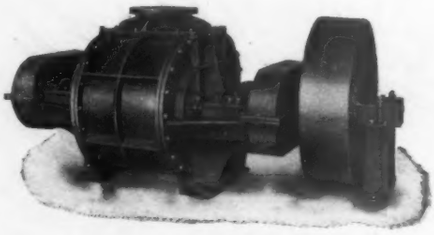
BRIDGE & OGDEN STREETS
NEWARK, N.J.
ESTABLISHED 1865



5 to 8 lb. Machine.

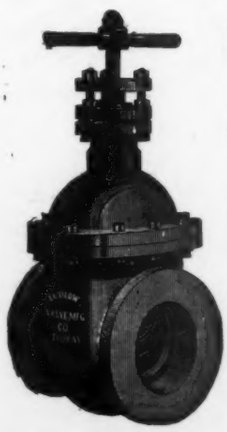
"PIQUA"

GAS EXHAUSTERS AND BLOWERS

Are Superior.

When in the Market, Write us.

THE PIQUA BLOWER COMPANY, - - - PIQUA, OHIO.



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TROY, N. Y., U. S. A.

Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

Send for Catalogue.

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Plans and Estimates Furnished for Extension of Gas Plants or Construction of New Works.

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Manufacturers of

High Grade Firebrick, Blocks, Tiles,

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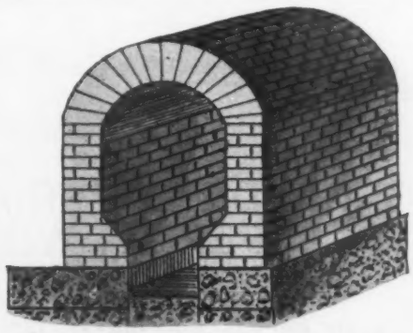
YOUR RETORTS WILL LAST LONGER.

Even a poor retort will stand where there is a good setting; but the very best retort will not last any time on a poor producer or setting. The first essential in a good bench is a good furnace crown or cover, and that is one point in which we excel. Another fact is our system of cross walls for supporting the retorts absolutely prevents settlement and stops all strains usually set up within the retort.



Write for Estimates on your Resetting Work. GAS WORKS DIVISION: A. S. B. LITTLE, Engineer.

COAL TAR AND AMMONIA,

By GEORGE LUNGE, PH.D. Third and Enlarged Edition.
Price, $15. For Sale by
A. M. CALLENDER & CO., 42 Pine Street, New York City.

"Ironclad" Dry Gas Meter
With Cast-Iron Case.

¶ Capacity with $\frac{3}{10}$-inch absorption, 120 cubic feet per hour; with $\frac{5}{10}$-inch absorption, 170 cubic feet per hour.

¶ Has all the advantages of tin meters, with addition of cast-iron case.

¶ Will not rust. Has no soldered seams to part.

See Catalogue G-1 for particulars.

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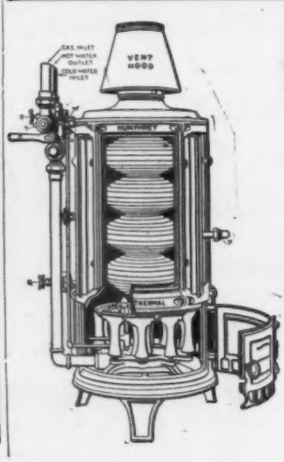
Manufacturers of Large Capacity and Ordinary Capacity Meters, Prepayment Meters, Proportional Meters and Meter Provers.

LLOYD CONSTRUCTION COMPANY

GAS APPARATUS.

DETROIT – MICHIGAN



Humphrey Auto-Thermal Instantaneous Water Heaters

Have every known desirable feature helping to efficiency, economy, durability and absolute safety.

FULLY GUARANTEED.
PRICES LOW.
QUALITY AND SERVICE HIGH.

Will you help us sell them?

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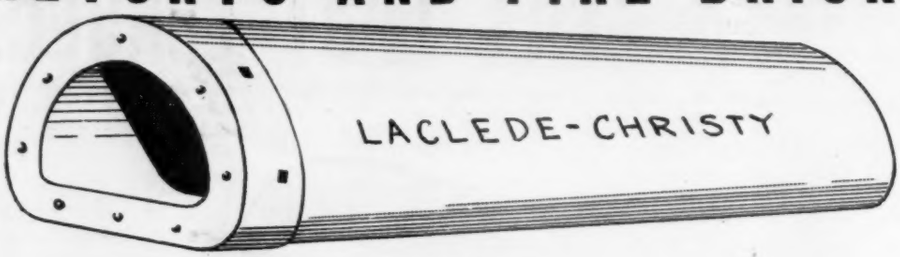
GAS BENCHES,
RETORTS AND FIRE BRICK.



LATEST DESIGNS,
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SUPERIOR WORKMANSHIP,
UNEQUALED RESULTS.

DESIGNS AND SPECIFICATIONS FURNISHED ON THE HORIZONTAL, INCLINED OR VERTICAL RETORT SYSTEMS FOR COMPLETE GAS WORKS.

LACLEDE-CHRISTY CLAY PRODUCTS CO.,
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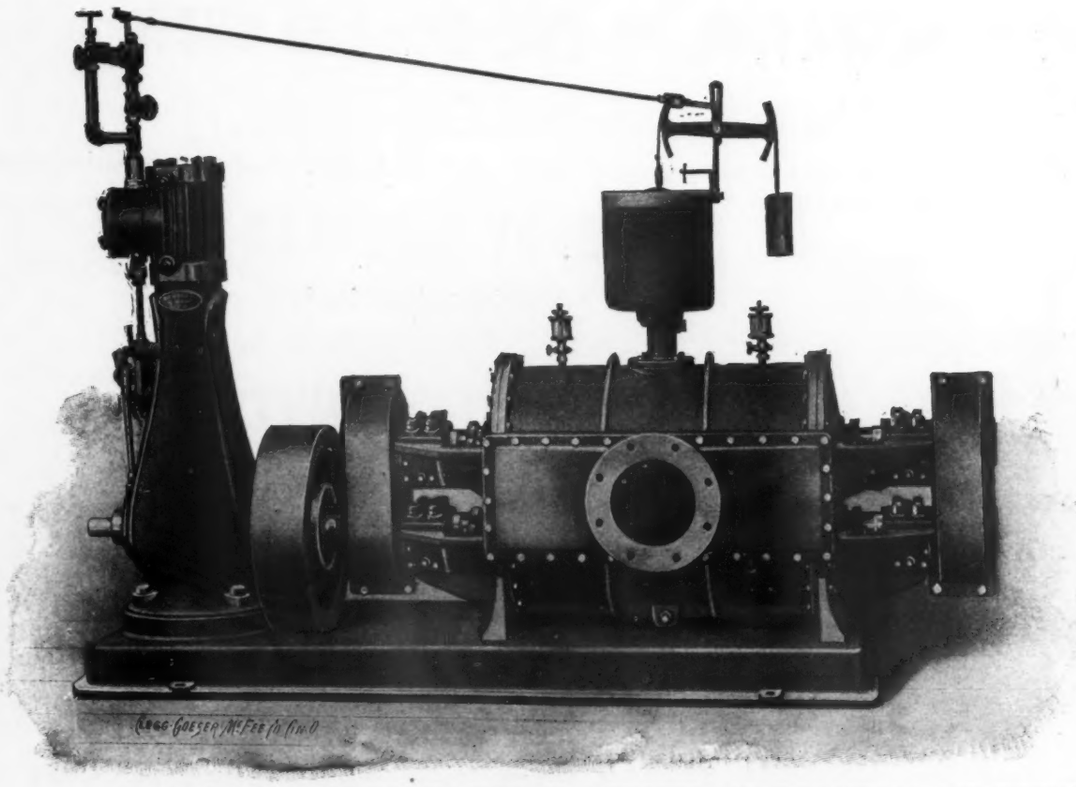
ROOTS' GAS EXHAUSTERS.



Sizes for any required capacity.

Self-oiling, adjustable bronze bearings.

Most perfect and sensitive Governor.

Write for Catalogue.

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Mueller Extra Gas Stove Cocks.

It is not the amount of color that the artist puts into his work that makes the picture.

It is the way he puts it in.

And so it is with gas cocks. It is not the amount of metal put into the cock--it is the way it is put in.

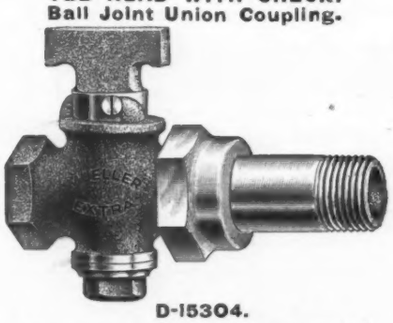
In Mueller Extra gas cocks a special red metal is used and is so distributed that the greatest amount is placed where the greatest strain comes.

Mueller Extra Gas Stove Cocks are made in flat, tee and socket head, with or without check. They have walls of uniform thickness and strong hexes.

UNCONDITIONALLY GUARANTEED.

TRADE MARK
MUELLER
REGISTERED

TEE HEAD WITH CHECK.
Ball Joint Union Coupling.



D-15304.

SOCKET HEAD WITH CHECK.
Ball Joint Union Coupling.

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Works and General Offices,
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H. MUELLER MFG. CO.

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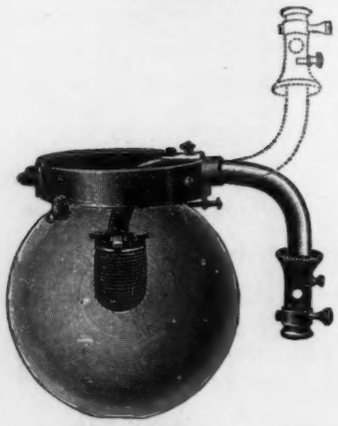
BRAY INVERTED BURNERS

WERE THE SENSATION OF THE CHICAGO SHOW.



With the gas pressure at 8-10ths and with other burners flashing and carbonizing,

THE BRAY INVERTED

filled the mantle perfectly and without a single flash back.

If you were at Chicago you know this to be a fact.

BRAY QUALITY COUNTS.

ORDER SAMPLES. YOU CAN SEND THEM BACK IF YOU WISH.

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MANUFACTURERS OF

CAST IRON PIPE AND SPECIAL CASTINGS

FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

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Manufacturers of

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BRISTOL'S

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RECORDING PRESSURE GAUGES, RECORDING VACUUM GAUGES,
RECORDING THERMOMETERS, RECORDING VOLTMETERS,
RECORDING AMMETERS, RECORDING WATTMETERS,

AND

THE WM. H. BRISTOL ELECTRIC PYROMETERS AND PATENT SMOKED CHART RECORDERS.

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New York, BRANCH OFFICES. Chicago,

WRITE for our Catalogue "O" just issued. This Catalogue deals entirely with "Brownhoist" Machinery as used at Artificial Gas Plants for handling coal, coke and other materials rapidly and economically.

THE BROWN HOISTING MACHINERY COMPANY,

Designers and Builders of All Kinds of Hoisting Machinery.

Main Office and Works:
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PRACTICAL HANDBOOK ON GAS ENGINES, WITH INSTRUCTIONS FOR CARE AND WORKING OF THE SAME,

By G. LIECKFELD, C.E. Translated with Permission of the Author, by GEORGE M. RICHMOND, M.E. Price, $1.

For Sale by A. M. CALLENDER & CO., 42 Pine St., New York City.

AMERICAN METER CO.,

NEW YORK, ST. LOUIS, PHILADELPHIA, SAN FRANCISCO, CHICAGO,

Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

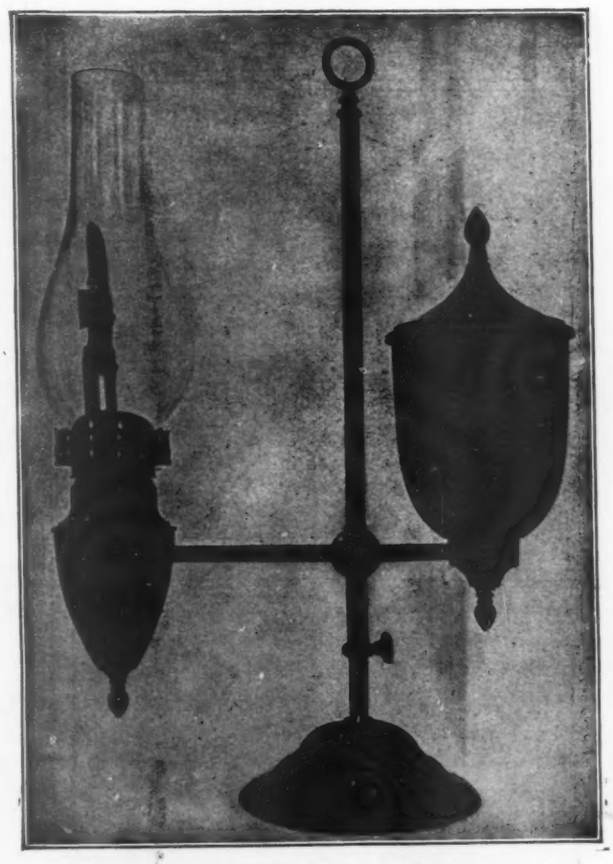
JANUARY, 1909.

Day of Week.	Table No. 1. FOLLOWING THE MOON. Date.	Light.	Extinguish.
Fri.	1	2.20AM	6.20 AM
Sat.	2	3.30	6.20
Sun.	3	4.30	6.20
Mon.	4	5.40	6.20
Tue.	5	No L.	No L.
Wed.	6	No L.FM	No L.
Thu.	7	No L.	No L.
Fri.	8	5.20PM	7.50PM
Sat.	9	5.20	8.50
Sun.	10	5.30	9.50
Mon.	11	5.30	10.50
Tue.	12	5.30	11.50
Wed.	13	5.30	12.50AM
Thu.	14	5.30LQ	1.50
Fri.	15	5.30	2.50
Sat.	16	5.30	3.50
Sun.	17	5.30	5.00
Mon.	18	5.30	6.20
Tue.	19	5.30	6.20
Wed.	20	5.30	6.20
Thu.	21	5 30NM	6.20
Fri.	22	5.30	6.20
Sat.	23	5.30	6.20
Sun.	24	5.40	6.10
Mon.	25	5.40	6.10
Tue.	26	10.00	6.10
Wed.	27	11.10	6.10
Thu.	28	12.20FM	6.10
Fri.	29	1.20	6.10
Sat.	30	2.30	6.10
Sun.	31	3.30	6.10

TOTAL HOURS DURING 1909.

By Table No. 1.

	Hrs.Min.
January	212.20
February	183.40
March	173.00
April	151.10
May	144.10
June	138.50
July	145.40
August	160.30
September	180.00
October	201.00
November	216.30
December	233.40
Total, yr.	2140.30



THE ELLIOTT KEROSENE STANDARD PHOTOMETER LAMP.

****

10-Candle Power.

****

This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

JANUARY, 1909.

Day of Week.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Date.	Complete Lighting in One Hour From Time Given P. M.	Complete Extinguishing in 50 Minutes From Time Given A. M.
Fri.	1	4.12	6.27
Sat.	2	4.12	6.27
Sun.	3	4.12	6.27
Mon.	4	4.12	6.27
Tue.	5	4.12	6.27
Wed.	6	4.12	6.27
Thu.	7	4.12	6.27
Fri.	8	4.22	6.22
Sat.	9	4.22	6.22
Sun.	10	4.22	6.22
Mon.	11	4.22	6.22
Tue.	12	4.22	6.22
Wed.	13	4.22	6.22
Thu.	14	4.22	6.22
Fri.	15	4.32	6.17
Sat.	16	4.32	6.17
Sun.	17	4.32	6.17
Mon.	18	4.32	6.17
Tue.	19	4.32	6.17
Wed.	20	4.32	6.17
Thu.	21	4.32	6.17
Fri.	22	4.42	6.12
Sat.	23	4.42	6.12
Sun.	24	4.42	6.12
Mon.	25	4.42	6.12
Tue.	26	4.42	6.12
Wed.	27	4.42	6.12
Thu.	28	4.42	6.12
Fri.	29	4.47	6.07
Sat.	30	4.47	6.07
Sun.	31	4.47	6.07

TOTAL HOURS DURING 1909.

	Hrs.Min.
January	428.30
February	358.15
March	353.10
April	298.10
May	263.20
June	234.45
July	248.30
August	278.00
September	311.25
October	370.05
November	397.40
December	438.35
	3980.25
Deduct on account of 50 min. extinguishing time	30.25
Total, yr.	3950.00

NEW YORK, 318 West 42d Street. BOSTON, 820 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Roe Building. CHICAGO, 218 La Salle Street. SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY

...OF AMERICA....

No. 36.

Controls and Operates the **Welsbach System of Street Lighting,**

Which includes its specially DESIGNED and PATENTED BURNER for PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

Welsbach Junior

THE BIGGEST LITTLE LIGHT IN THE WORLD.

The Welsbach Junior Light is 5 inches high--consists of burner, mantle and chimney--and is attractively boxed in a pasteboard carton.

As its effectiveness and economy become better known the Welsbach Junior will supersede, for universal use in the home, the old-style open flame gas burners.

Showing Welsbach Junior Light used in connection with ordinary glass globe.

Gives 50-Candle Power.

Uses Two Feet of Gas per Hour.

Attaches to Any Gas Fixture.

Completely Hidden from View.

Use your own globe--either gas or electric.

SMALL—EFFICIENT—ECONOMICAL.

Welsbach Company, FACTORIES: Gloucester, N. J. Columbus, O.

Salesrooms in all Leading Cities of the United States.

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Broad and Arch Streets, Philadelphia.

LESSEES, OPERATORS AND BUILDERS OF **GAS WORKS.**

Largest Builders of CARBURETTED WATER GAS PLANT IN AMERICA.

SOLE AMERICAN BUILDERS

OF THE

Standard Double-Superheater Lowe Water Gas Apparatus.

1907 CONTRACTS.

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Jenkintown, Pa. (2d contract).
Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
Atlanta, Ga. (2d contract).
Holyoke, Mass.
Peoria, Ills.
Schenectady, N. Y. (2d contract).
Danbury, Conn.
Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.
New Hartford, Conn.
Poughkeepsie, N.Y. (2d contract)
Nashville, Tenn.
Salisbury, Md.
Norfolk, Va. (4th contract).
Wallingford, Conn.
Richmond, Va. (2d contract).
Oak Bluffs, Mass.
Arlington, Mass.

TOTAL SETS INSTALLED DURING YEAR, ... 43
TOTAL SETS INSTALLED TO DECEMBER 31, 1907, ... 677
TOTAL DAILY CAPACITY, TO DECEMBER 31, 1907, ... 545,865,000 cu. ft.

Tar Extractors for Carburetted Water Gas.
Photometrical Apparatus.
Gas Analysis Apparatus.
Recording Gauges.
Straight Standpipe System for Coal Gas Retorts.
Straight Standpipe Cleaners.
Waste Heat Boiler.
Hygrometer.
Venturi Meter for Measuring Flow of Air Blast.

Established 1858. Incorporated 1890.
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CLAY GAS RETORTS, FIRE CLAY TILES, FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

ELECTRIC GAS LIGHTING.

How to install electric gas igniting apparatus, including the jump spark and multiple systems for use in houses, churches, theaters, halls, schools, stores or any large building. Also, the care and selection of suitable batteries, wiring and repairs.

By H. S. NORRIE.

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Practical Photometry,

By William Joseph Dibdin.

Price, ... $3.00.

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BALTIMORE RETORT & FIREBRICK CO.

BALTIMORE, MD.,

Manufacturers of all Material for the Construction of Coal Gas Benches.

HALF AND FULL DEPTH AND FREE FIRING BENCHES,

All styles of which we have in operation, equipped with the BEST of LATEST IMPROVEMENTS, proving our claim for SUPERIOR QUALITY and EFFICIENCY.

INCLINES—We have in SUCCESSFUL OPERATION benches of Inclined Retorts, MANUFACTURED and ERECTED by us.

WALDO BROS., 102 MILK ST., BOSTON, MASS.,
Agents for New England States.

LARGE FACILITIES—Correspondence Solicited.
RAIL and WATER CONNECTIONS to ALL POINTS.

L. C. HAMLINK, PRES. AUGUST COURT, SEC'Y.

GAS BENCH CONSTRUCTION COMPANY,

METROPOLITAN BUILDING, ST. LOUIS, MO.,

Engineers and Builders of all styles of Standard and Special Benches from one to twelve Retorts, Horizontal, Vertical, or Inclined.

We will guarantee "Better Benches," to be easier to control, make more gas per retort, and operate with less fuel than any bench on the market.

ALL WORKMANSHIP AND MATERIAL GUARANTEED.

JOHN DELL, *President and General Manager.*

MISSOURI FIRE BRICK CO.,

ESTABLISHED 1882.

MANUFACTURERS OF

Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.

We are the **Exclusive Agents** *for the* **Mitchell Patent Benches,** *Constructed with Half or Full Depth Furnaces, to Burn either Coal or Coke, and Arranged for Front or* **Rear Clinkering.** **The Mitchell** *is the* **Original Coal Firing Bench.** *We also Erect Plain Benches with* **One** *to* **Six Retorts.**

YOUR CORRESPONDENCE IS RESPECTFULLY SOLICITED.

City Office: *411 Olive Street, Continental Bank,* ST. LOUIS, MO.

EXPERT INSPECTION of Holders and Other Structures During Construction.
ECONOMIC DESIGN of Steel Structures, Reinforced Concrete, Masonry and Foundations.
CHAMBERS & HONE, Consulting Engineers, ... 15 William Street, New York City.

Bronder Patent Stoking Machinery.

Three-Scoop and Three-Rake Charging and Discharging Machines are operating in New York, Newark, N. J., Philadelphia, Worcester, Mass., Mt. Vernon, N. Y., Toronto and Montreal, Canada, Detroit, Seattle, Rochester and St. Louis.

Four-Scoop and Four-Rake Charging and Discharging Machines are operating in Detroit, Mich., and Cincinnati, Ohio. These are the only machines that will draw or charge simultaneously 3 or 4 retorts (vertically) and handle from 42 to 60 retorts in from 25 to 30 minutes, lid opening and closing and filling of furnaces included.

Hot Coke Conveyor, Quencher and Steam Exhauster, operating in Toronto, Canada, working in water-sealed flue, rollers being protected from heat and grit.

COAL CRUSHERS, CONVEYORS AND BINS. TURNTABLES FOR MACHINES.

Labor-Saving Machines for Handling Coal and Coke from Coal Cars to Coke Yard or Bins. Coke Screening and Measuring Plants a Specialty.

G. A. BRONDER,
Contracting Engineer and Builder,
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CONNELLY RETORT HOUSE GOVERNORS

WILL MORE THAN REALIZE EXPECTATIONS.

THEY ENSURE

Uniformity of Pressure or Vacuum Within the Hydraulic Main,
Increased and Constant Illuminating Power,
The Maximum Yield of Gas per Ton of Coal,

And Other Advantages which Speedily Return the First Cost.

CONNELLY IRON SPONGE AND GOVERNOR COMPANY,
NEW YORK. CHICAGO.

14-inch High Pressure Governor.

REYNOLDS' GAS REGULATOR COMPANY,

ANDERSON, IND., U. S. A.

We make all sizes for all classes of reduction,

Double and Single District Stations,

And Individual Service Governors for Reducing High Pressure.

HOLDER GOVERNORS

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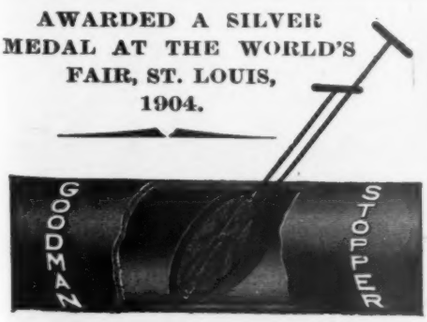

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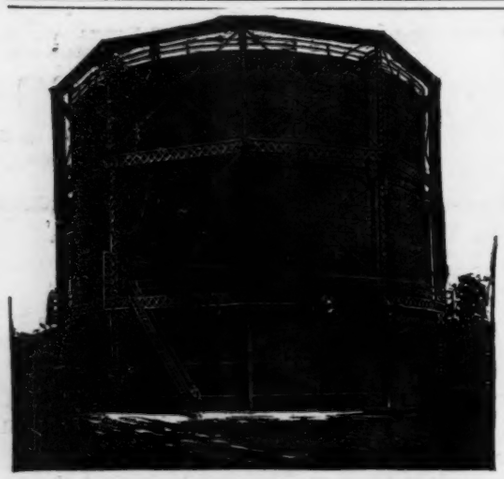

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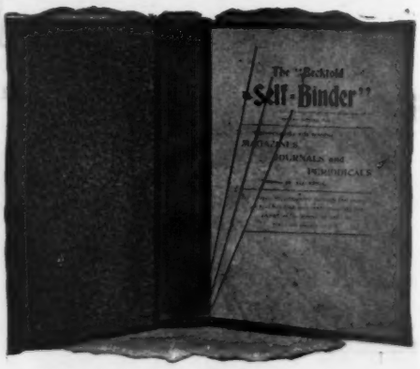

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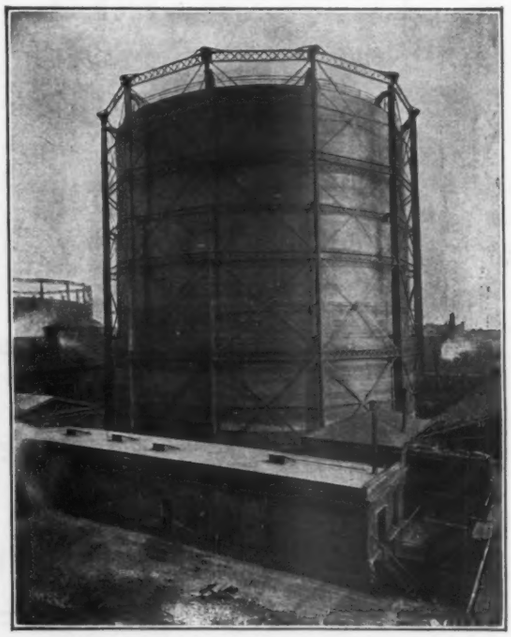

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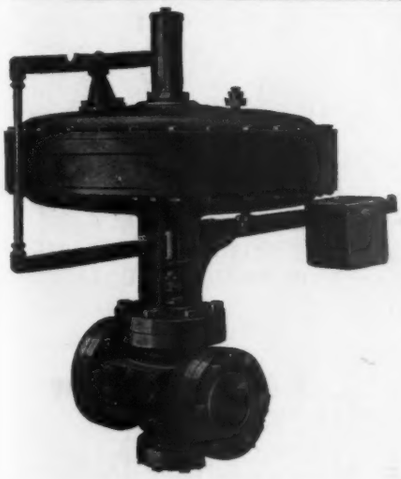

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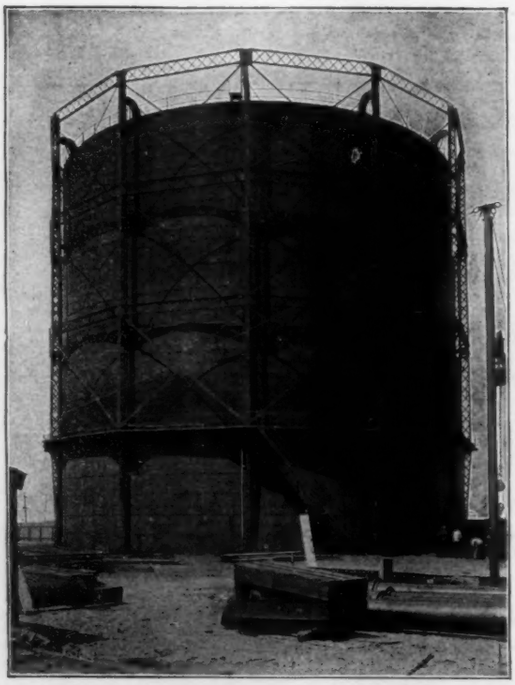

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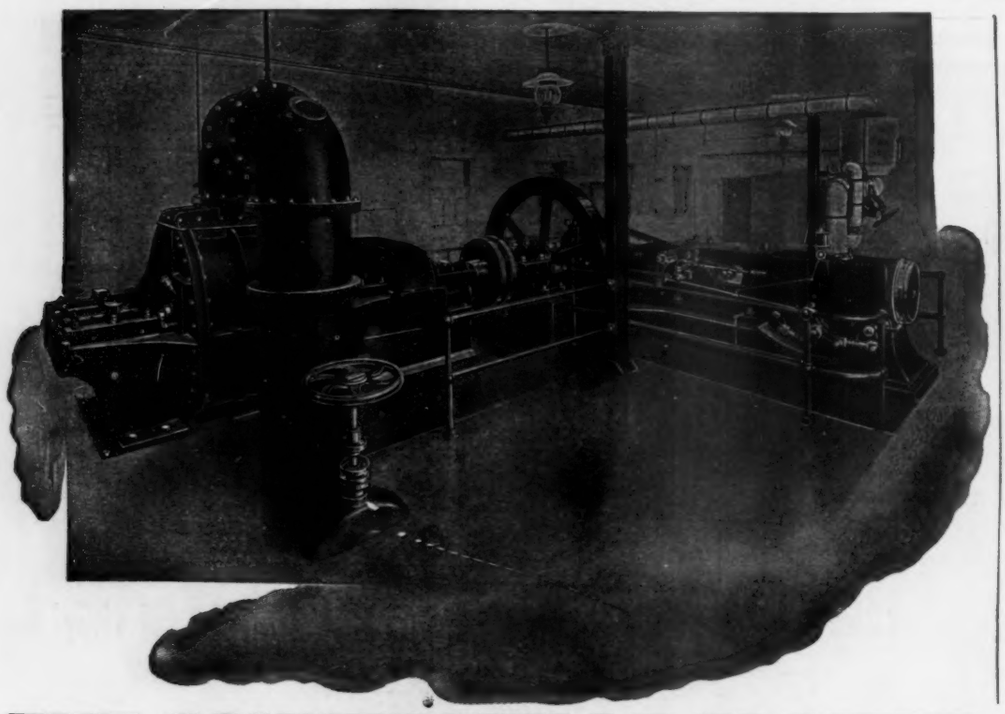

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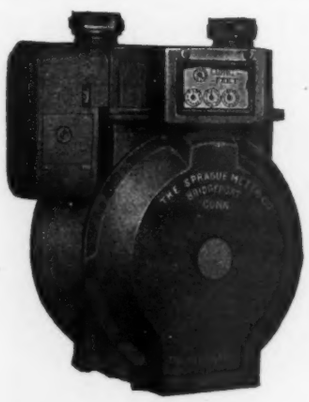

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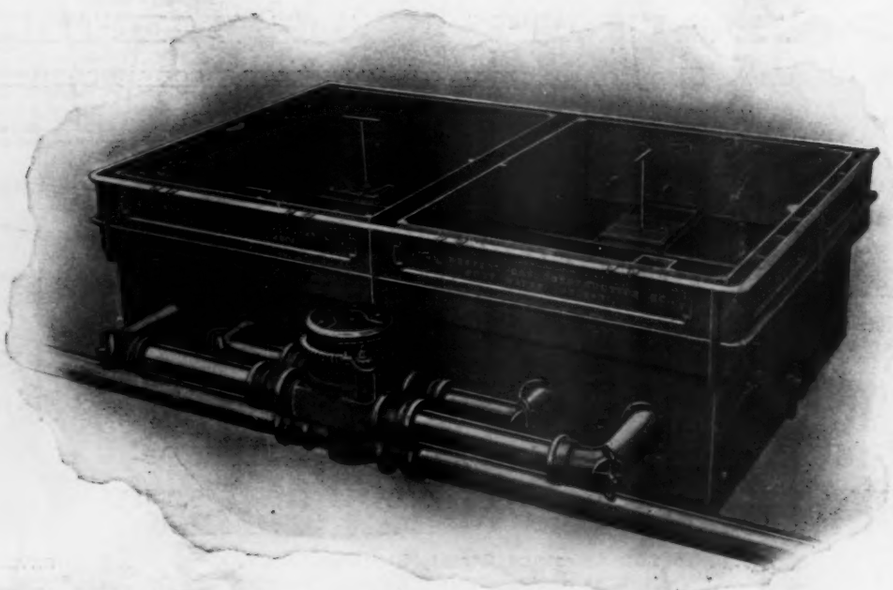

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